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INSPECTION MANUAL FOR ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS. PORTLAND CEMENT PLANTS

PEDCo-Environmental, Incorporated

PREPARED FOR
Environmental Protection Agency

January 1975

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Stationary Source Enforcement Series

INSPECTION MANUAL FOR ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS

PORTLAND CEMENT PLANTS

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement
Office of General Enforcement
Washington, D.C. 20460

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This document presents guidelines to enable enforcement personnel to determine whether new or modified portland cement plants comply with New Source Performance Standards (NSPS). Key parameters identified during subsequent inspections to determine the facility's compliance status. The portland cement process, atmospheric emissions from these processes, and emission control methods are described. The inspection methods and types of records to be kept are discussed in detail.

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PORTLAND CEMENT PLANTS

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1.0 INTRODUCTION

Pursuant to Section 111 of the Clean Air Act, the Administrator of the Environmental Protection Agency promulgated standards of performance for new and modified portland cement plants on December 23, 1971. These standards are applicable to portland cement manufacturing facilities whose construction or modification was commenced after August 17, 1971.

Each state may develop a program for enforcing new source performance standards (NSPS) applicable to sources within its boundaries. If the program is adequate, EPA will delegate to the state the authority for implementation and enforcement. Coordination of activities of the state agency and the EPA Regional Office is essential for effective operation of the NSPS program.

Long-term success of the NSPS program depends largely upon the adoption of an effective plant inspection program, primarily for monitoring of the NSPS performance tests and for maintaining routine surveillance. This manual provides guidelines for conducting such field inspections. The basic inspection procedures presented herein should also be of use in enforcing emission regulations affecting portland cement plants contained in state air quality implementation plans.

2.0 SUMMARY OF NEW SOURCE PERFORMANCE STANDARDS

Standards of air pollution control performance for new and modified portland cement plants were originally proposed on August 17, 1971. The standards promulgated on December 23, 1971, altered the particulate sampling method but held constant the allowable emission rate from cement kilns and clinker coolers, resulting in a slight relaxation of the emission standards. New source performance standards are subject to Federal regulation code 40 CFR 60. The title 40 designates "Protection of Environment"; part 60 classifies new sources. On March 21, 1972, EPA issued a "Supplemental Statement" noting that the change in the sampling method without a change in the allowable emission rate permits electrostatic precipitators as well as fabric filters to meet the emission standard.

An amendment on May 2, 1973, recognized that start-ups, shutdowns, and malfunctions are not representative conditions of performance tests unless otherwise specified. In addition, the amendment simplified reporting requirements. Section 60.62 was revised on November 12, 1974, changing the opacity limit for kilns from 10 percent to 20 percent.

The standards are summarized in Section 2.1. Several conditions needing further interpretation are discussed in Section 2.2.

2.1 SUMMARY OF NSPS

The emission standards for new or modified cement plants are summarized below. The regulations, with revisions through November 12, 1974, are given in Appendix A.

2.1.1 Emission Standards

Allowable limits for particulate matter and opacity are presented below.

Operation	Particulate		Opacity
Kiln	0.15 kg/metric ton 0.3 lb/ton	of kiln feed	≤20%
Clinker	0.05 kg/metric ton 0.1 lb/ton	of kiln feed	<10%
All others	None		<10%

2.1.2 Monitoring and Reporting

Portland cement plant owners are responsible for maintaining records of daily production rates, kiln feed rates, malfunction episodes and quarterly reports of excess emissions.

2.1.3 Performance Testing

Testing of new or modified sources must be performed no later than 60 days after achieving maximum production rate, but no longer than 180 days after initial start-up. The tests must be conducted at representative performance using fuels and raw materials representative of those used during normal operation.

The owner or operator has the following responsibilities:

- To give a minimum of 30 days notification of scheduled tests.
- To give a minimum of 30 days notice of anticipated start-up. EPA must be notified of the actual start-up date within 15 days after such date.
- To provide adequate sampling ports, safe sampling platforms, safe access to the platforms, and utilities for sampling and testing equipment.
- To perform emission tests and furnish a written report of test results to the Administrator.

The particulate testing method is specified in 40 CFR 60. Each test consists of three runs of the applicable test method. Results of the repetitive tests are averaged to determine compliance. EPA personnel may perform additional tests at any reasonable time at any representative load condition.

2.2 APPLICABILITY OF STANDARDS

Certain aspects of cement manufacture may present difficulty in application of the performance standards. The enforcement officer may wish to consult with his superiors concerning circumstances not specifically covered in the NSPS.

Compliance Test Deadlines

Although the standards require emission tests no longer than 180 days after initial start-up, several manufacturers indicate that under some circumstances, the period required for adequate shakedown of kiln operations may exceed the time alloted to perform the tests.

Preheater Status

Rising fuel costs will influence cement manufacturers who design new plants to incorporate preheating systems for partial calcination of the raw feed. Preheaters are an integral part of the kiln system. Therefore, the kiln standards apply to the combined kiln-preheater system.

Combined Exhaust Gases

Particulate standards for kilns are 0.3 lb/ton of dry, raw feed to the kiln and for clinker coolers, 0.1 lb/ton of dry, raw feed to the kiln. Some existing facilities vent exhaust gases from both units through the same control device and stack.

Venting Systems

Some baghouses are on the pressure side of the kiln draft fan. They may vent the clean gas through stacks, or through openings in the sides and top of the baghouse. Since the standards require an exhaust system which is acceptable for conducting emission tests, the agency reviewing the permit to construct should inform the cement facility that a closed control system may be economically advantageous over an open baghouse.

3.0 PROCESS DESCRIPTION; ATMOSPHERIC EMISSIONS AND CONTROL METHODS

Portland cement is a powdered material which, with water, forms a paste that hardens slowly, bonding rock, gravel, and sand into concrete. Portland cement is defined by ASTM C150 as, "a hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulfate as an interground addition."

3.1 PROCESS DESCRIPTION

Portland cement production involves quarrying and crushing, grinding and blending, clinker production, and finish grinding and packaging. Flow charts depicting the various steps are shown in Figure 3.1. Portland cement production requires two types of raw materials and two separate grinding operations.

3.1.1 Quarrying

The raw materials for producing portland cement contain calcium and silica as principal components, and alumina and ferric oxide as fluxing components. Calcium sources are limestone, marble, marl, oyster shells, and waste sludge from lime plants. The other materials are obtained from clay, shale, bauxite, silica sand, iron ore, and waste from other industries.

The most common combination of raw materials is limestone and clay or shale, carefully blended to yield the final chemical proportions required in the cement. Limestone and shale are blasted from quarries, usually close to the cement facility. The raw material is transported to the primary crusher by dump trucks loaded by power shovels, by narrow-gage railroads with hopper cars, and by conveyor belts.

3.1.2 Crushing and Grinding

The primary crusher reduces rock as large as 4 to 5 feet across to fragments 6 to 10 inches across. The most common types of primary crushers, are the gyratory, jaw, and roll crushers. Figure 3.2 illustrates the gyratory and roll

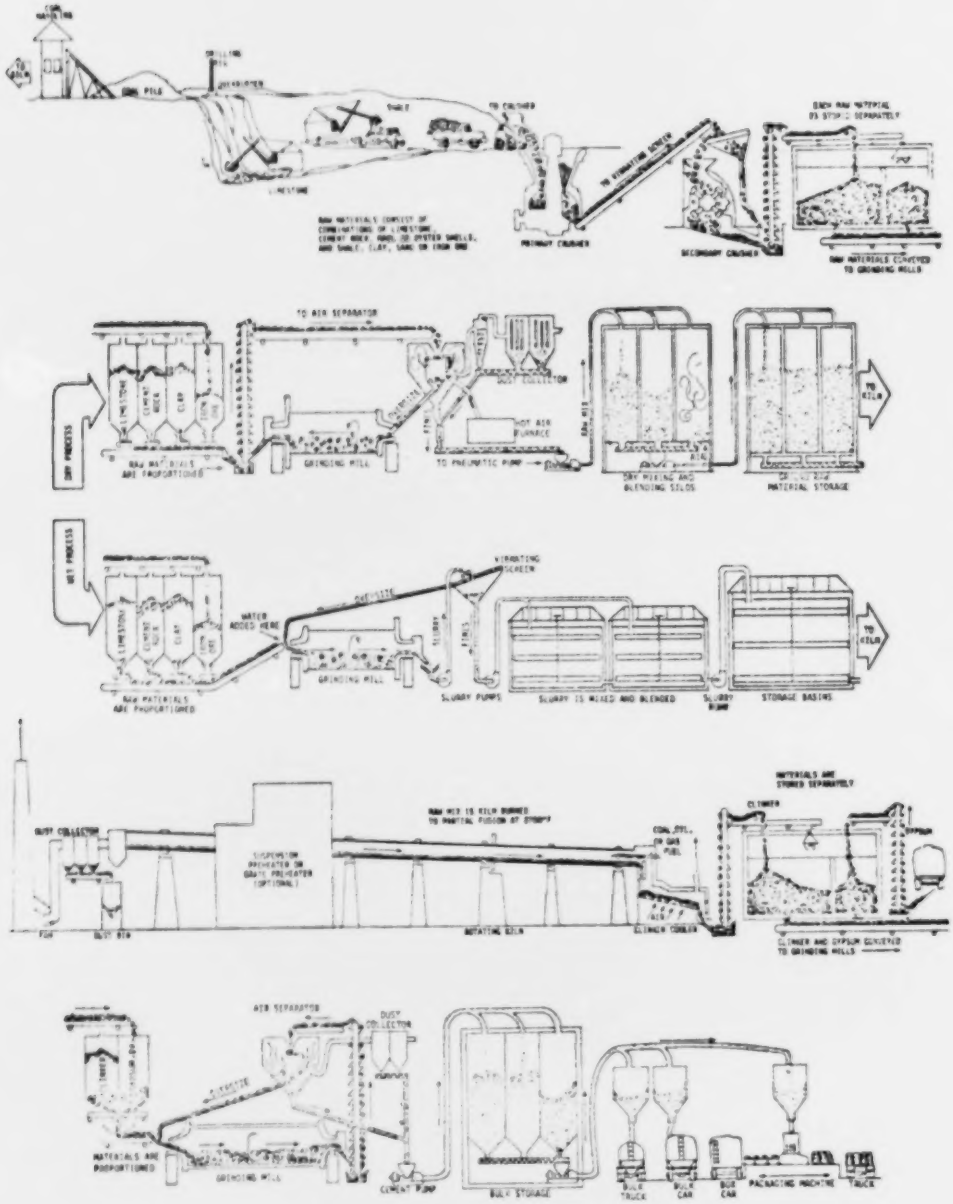

Figure 3.1 Portland cement process flow diagram.

(Courtesy of Portland Cement Association
Old Orchard Road, Skokie, Illinois)

Reproduced from best available copy.

Figure 3.2 Gyratory (a) and roll crushers (b) used for grinding raw materials.

crushers. A steel cone in the center of a gyratory crusher presses material against an outside steel wall. A "jaw" crusher employs steel rolls studded with teeth. As the rolls rotate, the teeth crush the rock against steel plates.

After the rock is broken by the primary crushers, it is carried by conveyors to the secondary crushers, usually of the "hammer mill" type. Rock crushed by the hammer mill is usually less than 3/4 inch across.

3.1.3 Grinding, Blending, and Raw Material Storage

The crushed raw material undergoes a fine grinding process, which further reduces the rock size in preparation for processing in the kiln. The fine grinding technique depends upon whether cement is produced by the wet or dry process. Ball and rod mills, used in both processes, work on essentially the same principle. Cylindrical shells with protruding ridges carry the balls or rods part way up the side of the drum as it rotates. They then cascade back down into the raw material and grind it to a fine consistency. Balls and rods must be periodically replaced due to abrasion.

Wet Process

Raw feed, fed in the grinding mills, is combined with water to form a slurry. The slurry, consisting of more than one-third water, is discharged from the mill and stored in huge open tanks where additional homogenation takes place.

The "wet process" slurry is usually pumped directly to the kilns. In some instances, moisture is removed by vacuum filters, thickeners, or hot kiln exhaust gases.

Dry Process

Hot gases for drying are provided by direct firing of separate furnaces or by flow of exit gases from the kiln. Ground raw materials are proportioned as they enter the mills. The milled rock must be finely ground and thoroughly mixed to produce uniform clinker composition. In closed-circuit grinding, air separators return the coarse fraction to the mill for further grinding, while the fine fraction goes to a series of silos, bins, or storage buildings.

3.1.4 Calcination and Clinker Production

Dry feed or wet slurry is "burned" in a kiln to form portland cement clinker. The rotary kiln shown in Figure 3.3 is a steel cylinder with a refractory lining, slightly inclined downward from the intake to the discharge end. Raw materials are fed into the high end through a kiln feeder. Fuel in the form of pulverized coal or coke, oil, or natural gas is blown in with hot air, which is heated by passing through clinker in the coolers at the discharge end of the kiln.

Figure 3.3 Typical portland cement rotary kiln.

(Courtesy of Allis-Chalmers Cement and Mining Systems Division, Milwaukee, Wisconsin)

As the kiln revolves, the raw materials roll and slide downward toward the lower end, gradually becoming exposed to more and more heat. Water is first evaporated in the upper part of the kiln. A chain system within the kiln promotes the heat transfer. In the middle of the kiln, carbon dioxide and combined water are driven from the raw materials, and the original limestone, silica, iron ore and clay are changed into new compounds, such as calcium silicates, aluminates, and ferrites. The lower third of the kiln is the burning zone, maintained at temperatures of approximately 2700°F, where the material becomes incandescent. The clinker appears in the form of round, marble-size, glass-hard balls.

Some kilns have a uniform diameter throughout their length, others have either or both the feed end and the discharge end enlarged. The feed end is enlarged to reduce gas velocities and thus reduce dust loadings to the control equipment. The discharge end is enlarged to accomodate the higher gas volumes due to the high temperatures, and to provide more surface exposure to the flame.

Operation of new or modified kilns is controlled by instrumentation, direct digital control, or by computers. Kiln rotation speed, material feed rate, burning temperature profile, exhaust gas composition, draft, and fuel usage are closely monitored and adjusted as required to produce good clinker.

Planners of new cement operations are considering new techniques for clinker production to combat rising fuel costs. Alternatives to using conventional kilns include longer kilns, suspension preheaters, and traveling-grate preheaters.

In a suspension preheater, shown in Figure 3.4, dry, raw feed is fed downward through a series of cyclones against an upward gas flow, resulting in an effective counter-current heat exchange. The gas, supplied by the kiln exhaust, does not require an additional heat input, although some flash preheating systems are now being introduced.

A traveling-grate preheater system is shown in Figure 3.5. Ground raw meal is pelletized and discharged to a hopper at the feed end of the traveling grate. A uniform bed of pellets is spread across the full width of the traveling grate. The pellets are heated and partially calcined before entering the rotary kiln.

The clinker drops from the lower end of the kiln into some form of cooler where its temperature is quickly reduced. New or modified designs carry the clinker on a perforated grate through which air is forced. A portion of hot over-grate air is used as combustion air for the kiln.* From the cooler, the clinker is either stockpiled or transferred immediately to the finish mills.

Finish Grinding and Packaging

Gypsum, required to regulate the cement setting time, is mixed with the clinker before it enters the grinding mills. Clinker and gypsum are usually ground in a compartment mill close-circuited with an air separator. The clinker may be crushed before entering the mill, but there are probably few two-mill systems in modern plants. The finished cement is shipped either in bulk or in bags. Bulk cement is carried by barges, tanker trucks, or hopper bottom cars filled from large silos. Automatic packaging machines are used to bag the cement. One bag of portland cement weighs 94 pounds; a barrel consists of four bags, or 376 pounds.

3.2 ATMOSPHERIC EMISSIONS

The potential sources of emissions from portland cement plants are illustrated in Figure 3.6. All sources are subject to NSPS (40 CFR 60, Section 60.62), except fugitive dust emissions (points 1, 8, 16, 26). Many facilities minimize fugitive dusts by using vacuum trucks to clean the plant grounds.

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* The amount of air recycled to the kiln is governed by the kiln excess air; 1 to 2 percent O_2 eliminates potential explosions without lowering kiln temperatures.

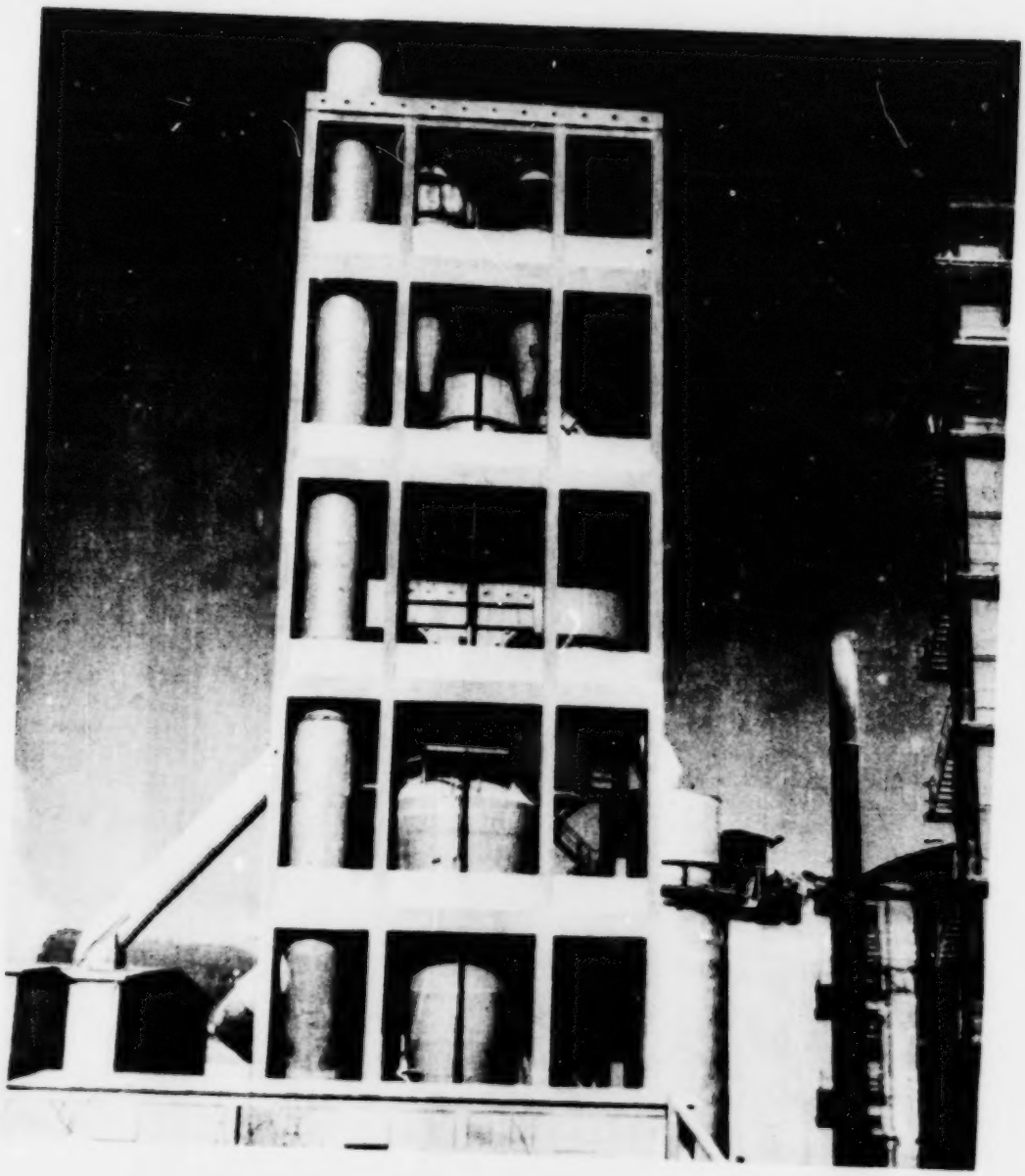

Figure 3.4 Dry process suspension preheater.

(Courtesy of Allis-Chalmers Cement and Mining Systems Division, Milwaukee, Wisconsin)

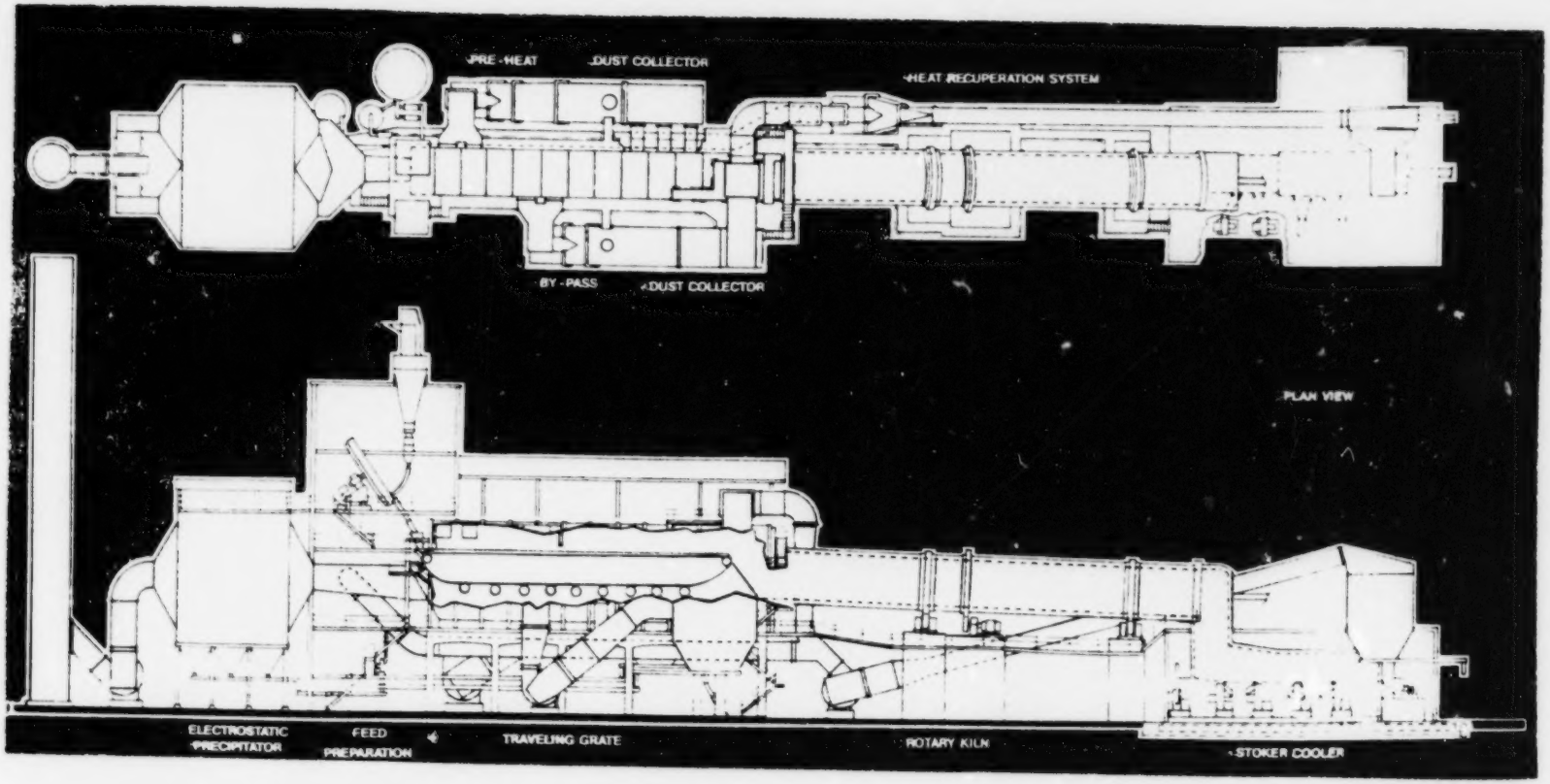

Figure 3.5 Traveling-grate preheater system.

(Courtesy of Allis-Chalmers Cement and Mining Systems Division, Milwaukee, Wisconsin)

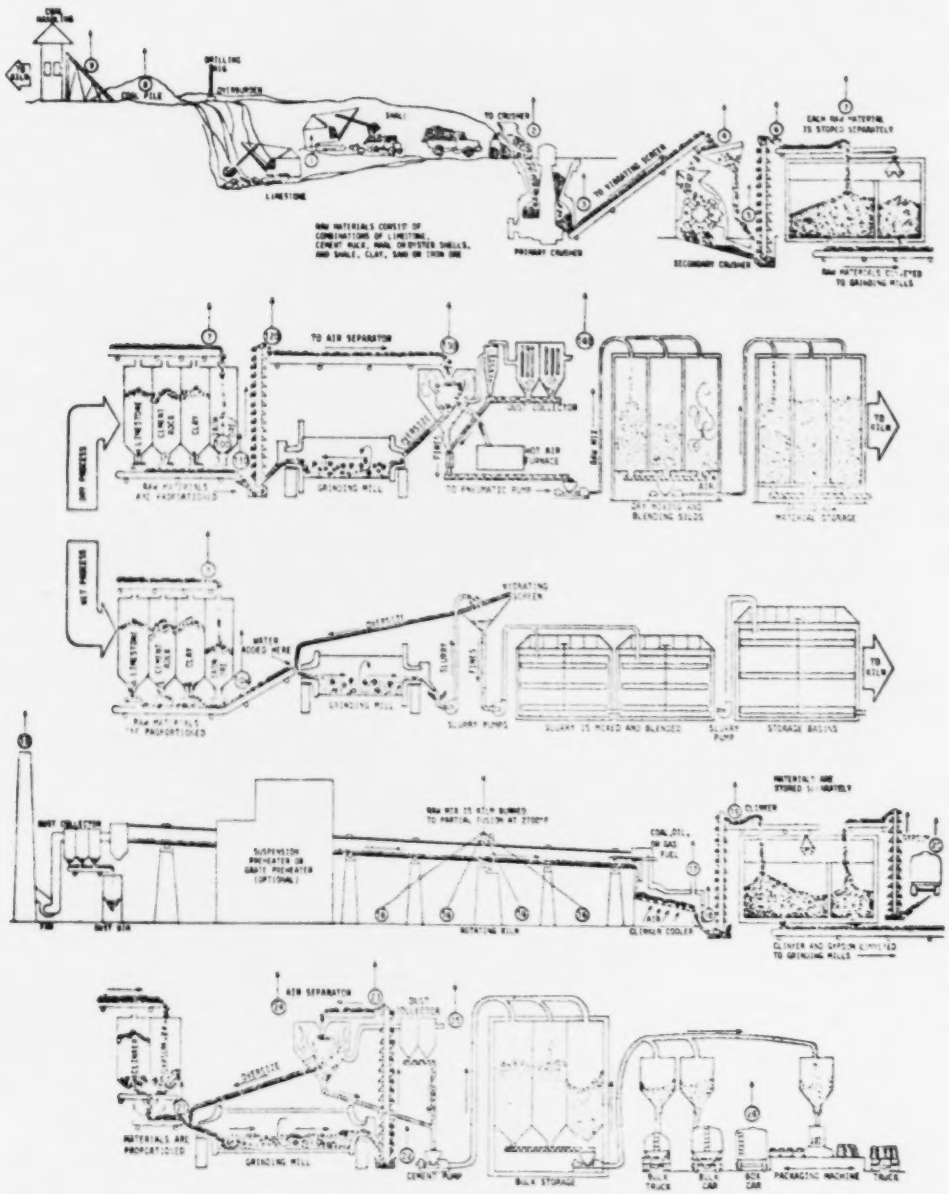

Figure 3.6 Potential emission sources from portland cement plants.

Potential Emission Sources from Portland Cement Plants
(Key for Figure 3.6)

1	fugitive emissions from rock quarry
2	transfer emissions from feed entry to primary crusher
3	transfer point to conveyor
4	transfer point to secondary crusher
+5	transfer point to rock handling elevator
6	transfer point to conveyor
7	transfer point to material storage areas
+8	fugitive emissions from coal pile
+9	emissions from coal transfer to kiln
10D	transfer point to conveyor; 10W transfer point to conveyor
11D	transfer point to rock handling elevator
11D	transfer point to conveyor
13D	transfer point to grinding mill feeder
14D	grinding mill vent
*15	kiln exhaust
16	fugitive emissions from cement facility
*17	clinker cooler exhaust
18	transfer point to clinker elevator
19	transfer point to clinker conveyor
20	transfer point to gypsum conveyor
21	transfer point for proportioned material
•22	transfer point to separator elevator
•23	transfer point to air separator conveyor
•24	transfer point to air separator
•25	grinding mill exhaust
26	loading operation fugitive emissions

+ Sources not applicable to all portland cement operations.
* Quantitative allowable limits.
• Closed-circuit mill systems do not emit particulate to the atmosphere.

Many of the emission areas are at the ends of material conveying devices, called "transfer points." Uncontrolled emissions at transfer points are reduced by lightly spraying the feed with water or an aqueous chemical solution.

Exhaust gases from kilns, clinker coolers and dry milling systems constitute the larger emission sources. In the wet process plants, raw materials are not dried but are ground with water to form a slurry; therefore, the only dust is liberated from the transfer point at which rock is fed into the grinding mill (10W).

Seal rings minimize the gap between stationary and rotating components on both ends of the kiln. The kiln draft is always negative at the feed end. The pressure at the discharge end hood may go temporarily positive, which results in "puffing," and the discharge of clinker dust. The amount of particulate emitted to the atmosphere is minimal.

3.3 CONTROL DEVICE APPLICATIONS

Particulate matter is the primary pollutant from the manufacture of portland cement. The cement industry uses mechanical collectors, electrostatic precipitators, gravel beds, and fabric filter (baghouse) collectors or combinations thereof, depending upon the operation and exhaust gas temperatures. Although high-energy wet collectors (venturi scrubbers) are used in several plants, they are not generally used in the portland cement industry.

At the numerous transfer points in the cement plant, cloth filters are used extensively to recover the dust. A 2000-acfm low-temperature baghouse, collecting dust from a primary feed conveyor is shown in Figure 3.7. Properly designed hoods, used with 1000-4000 cfm fans, effectively control emissions. Increasing fan capacity only results in drawing excess raw material off the conveyor; dust control depends strongly upon design of the entire control system.

Raw and finish milling processes are usually controlled by fabric filters, although precipitators effectively clean exhaust streams from finish mills. The control devices, connected in a closed loop with air separators, transport the collected material back to the process for cement production.

Control of dust from the kiln, the largest dust source in a cement plant, requires a baghouse or electrostatic precipitator. Baghouses have a history of more reliable operation than precipitators, although precipitators require less energy and operate at lower costs.

Many kiln operations equipped with precleaning mechanical collectors recycle dust back to the kiln. Fine kiln dust, however, contains more alkali than normal kiln feed. Portland cement containing in excess of 0.6 percent alkali is not recommended for use with certain aggregates which are classified as reactive. As a consequence, only a portion of dust collected from baghouses and precipitators is used for kiln feed, depending on portland cement specifications. The dust collected from precipitators can be separated into fractions with variable alkali content.

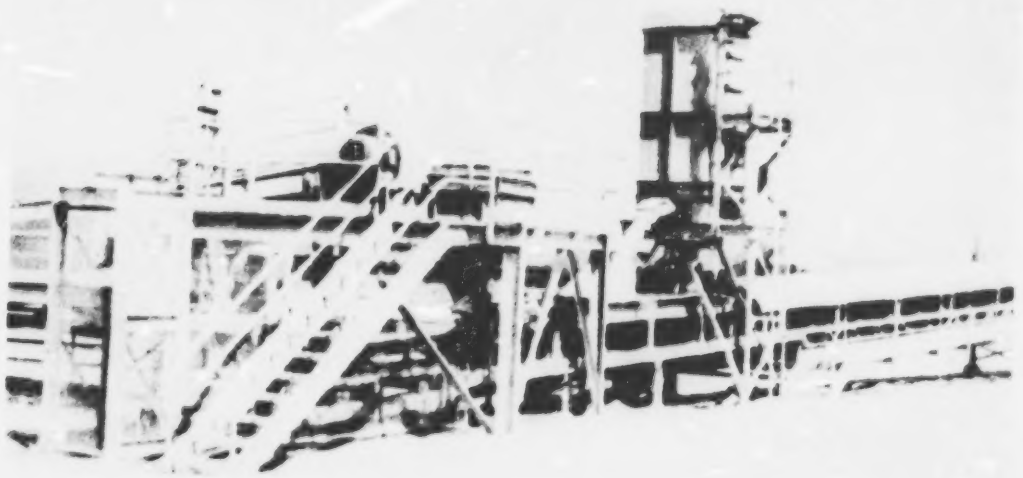

Figure 3.7 Feed conveyor transfer point with control device.

(Courtesy of California Portland Cement Company, Los Angeles, California)

Kiln exhaust gases must be cooled to at least 600°F before entering fabric filters. Glass and Nomex fabrics, which withstand 550°F and 450°F respectively, are the most commonly used in bags. Higher temperatures accelerate the aging of bag fabrics.

When baghouses control dry-process kilns, gas temperatures are of primary concern. When precipitators are used on dry kilns, water cooling and conditioning can overcome problems of resistivity and sulfate buildup.

When either precipitators or fabric filters are used on wet-process kilns, extensive thermal insulation must be provided to prevent condensation of water vapor within the device. Although some precipitators are specified to withstand a maximum temperature of 700°F, the usual operating range is 300 to 500°F. Wet-process kiln gases exhibit the proper moisture and temperature characteristics for effective electrostatic precipitation. Water conditioning improves particle resistivity in dry kilns, and reduces the temperature. Several preheater installations utilize the kiln exhaust gases to dry the raw material. This increases the moisture content of the gas and reduces its temperature.

The relatively small particle size of clinker cooler dust requires high-energy control devices to meet NSPS. A horizontal-grate clinker cooler equipped with a 16-compartment baghouse is shown in Figure 3.8. Although precipitators are not generally used for clinker cooler control, there are several successful installations in use. If the unit is properly designed, it may not be necessary to achieve collection efficiencies by adding water, except on an emergency basis to prevent overheating.

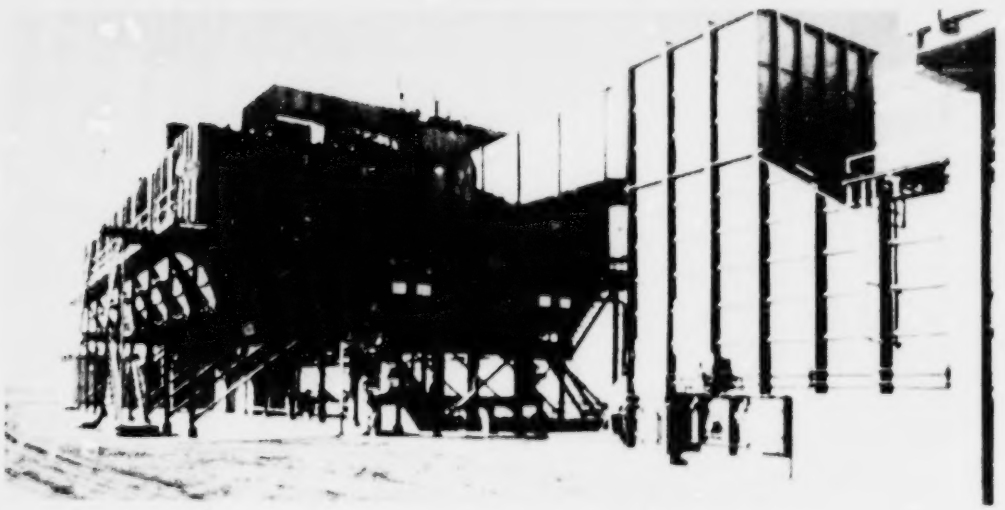

Figure 3.8 Horizontal-grate clinker cooler.

(Courtesy of California Portland Cement Company, Los Angeles, California)

Gravel-bed filters are achieving some popularity to clinker coolers. The filter media consists of silica gravel which is insensitive to temperature. These collectors handle operating temperatures to 1000°F with no gas cooling or conditioning required.

A common practice is to reclaim heat by using exhaust gases as preheated air in other operations, (e.g., kiln exhaust serving as preheater air, clinker cooler gases used for kiln combustion air). For conventional long wet- or dry-process kiln systems, fans are positioned either ahead of or after the collector, fabric filter or precipitator, due to the low pressure drop of the system. However, for a preheater kiln, the collector, due to the extremely high pressure drop, must be located after the main kiln draft fan to alleviate ambient air infiltration into the gas stream.

Table 3.1 summarizes the various types of control equipment used throughout the portland cement facility.

Table 3.1 ADVANTAGES/DISADVANTAGES OF CONTROL DEVICES FOR VARIOUS CEMENT OPERATIONS

Operation	Mechanical collectors	Fabric filters	Electrostatic precipitators
Quarrying	Not applicable	Not applicable	Not applicable
Crushing and grinding	Not applicable	**Very good**	Not economically feasible; low flow volumes
Raw material storage	Not applicable	**Very good**	Not economically feasible
Integral preheater and kiln	Integral part of preheater countercurrent gas and material flow; high energy controls necessary to meet opacity requirements	**Very good**; must contend with temperature reduction, dewpoint	**Very good**, if gas stream is properly conditioned
Kiln	Used as precleaners for high energy devices	**Very good**; must contend with temperature reduction, dewpoint	**Very good**; must contend with dewpoint particle resistivity, and explosion potential problems
Clinker cooler	Used as precleaners for high energy devices	**Very good**; must contend with abrasive particulate. Gravel-bed filters have been recently introduced	Precipitator design must contend with combination of clinker dust and moisture, possibly coating ESP interior with cement
Finish grinding	Cannot meet opacity requirements	**Very good**	**Very good** on large mills
Finished material storage	Cannot meet opacity requirements	**Very good**	Not economically feasible; low air flow volumes
Packaging and shipping	Cannot meet opacity requirements	**Very good**	Not economically feasible; low air flow volumes

4.0 PROCESS, CONTROL DEVICE, AND EMISSION MONITORING INSTRUMENTATION: RECORDS AND REPORTS

Central control facilities incorporated on many of the new portland cement plants handle the various phases of cement production automatically. Daily production rates, kiln feed rates, and any particulate emission measurements, as required by NSPS, are either recorded on charts or logged by hand. Monitoring of process variables, discussed in Section 4.1, will aid the inspector in determining whether the cement facility complies with regulations.

The reporting requirements, summarized in 40 CFR 60, appear in Appendix A. The present reporting requirements are discussed in Section 4.2.

4.1 INSTRUMENTATION

Process Instrumentation

Of interest to the enforcement officer are instruments indicating process feed and production rates. The facility must be operating at representative performance during performance tests. Feed rates to the kiln recorded during the performance test serve as reference values for future inspections.

Control Device Instrumentation

Although a theoretical relationship between pressure drop through a control device and efficiency of the collector can be cited, many process changes (e.g. frequency of bag cleaning, kiln ring formations), also cause pressure differential to fluctuate and thus interfere with pressure drop/efficiency relationships. Therefore, change in pressure across the control device is not a valid indicator of emissions from kiln and clinker cooler; the pressure changes may be attributable to other factors.

For kilns equipped with electrostatic precipitators, efficiency depends on input power. A significant variation in voltage or current changes the collection characteristics, resulting in higher or lower emissions. Precipitator instrumentation, defined in Sections 6 and 7, will enable the enforcement officer to determine whether precipitator performance has significantly deteriorated.

Emission Monitoring Instrumentation

Emission monitors are not required on portland cement operations. If plant officials elect to install particulate monitors, however, the results are to be recorded and filed each day. Many companies prefer transmissometers, which both monitor and record stack opacities. Opacity detectors are only installed on wet kiln stacks if the temperature is above the dewpoint, because the high moisture content of the exhaust gases can interfere with opacity readings.

4.2 RECORDS AND REPORTS

Recordkeeping enables control officials to review the portland cement operation without frequent visits to the facility. During periodic visits the inspector reviews the plant records and notes any deviations from conditions at the time of the performance test. Such comparisons should reveal whether the source complies with particulate standards.

Recordkeeping and reporting requirements for portland cement facilities are summarized in Parts 60.7, 60.8, and 60.63 in 40 CFR 60. The NSPS specify that the portland cement facility only maintain records of production and kiln feed rates, but other important parameters are listed in Table 4.1.

Although records of daily production rates are required by 40 CFR 60, variations in output are detected from finish milling rates, not production from the kiln or clinker cooler. Operating hours and control device parameters, shown in Table 4.1, are records the inspector can review during subsequent visits.

Some opacity monitors are equipped with lens protective shutters which close when a malfunction occurs. In these instances, there will be no opacity readings during the malfunction.

The only reporting requirement is that plants submit a quarterly report of any estimated or measured emissions greater than those during the performance tests.

Table 4.1 RECORDS RECOMMENDED FOR PORTLAND CEMENT FACILITIES

Parameter	Units	Comments
Production rates	tons/day	Record daily production rates.
Kiln feed rates	tons/day	Note moisture content of feed, if possible.
Hours of operation	hours/day	Record daily hours of operation. Log process start-up and shutdown times.
Performance testing		File report of test results.
*Precipitator power for each section	KV and ma	Note appreciable deviations from values during performance tests.
*Fabric filter maintenance		When replacing original bags with different types, identify new fabric.
Particulate measurements	% transmittance	*Record calibration dates. Date graphs when recorder charts are used.
Start-ups, shutdowns, malfunctions		Record any process malfunction that directly or indirectly increases particulate emissions.

* Not required by 40 CFR 60.

5.0 START-UP/SHUTDOWN/MALFUNCTIONS

Start-up, shutdown, and malfunctions of a portland cement operation are not defined as "normal operating conditions." These conditions may, and in most instances do, cause emissions to exceed the opacity limits specified in NSPS. Accordingly, the standards will not apply in such cases. The effects of start-ups and shutdowns of the major processes (kilns and clinker coolers) are discussed in Sections 5.1 and 5.2; Section 5.3 reviews the malfunctions that contribute to increased emissions. Responsibilities of plant officials with respect to malfunctions are outlined in Section 5.4.

5.1 START-UP

During start-up of a completely cold kiln, the firing temperature is gradually raised over a period of time, which is a function of the last refractory installation. Start-up usually requires from 4 to 6 hours, but some kilns may need as much as 48 hours.* Once feed is introduced to the kiln, the flame is increased to preheat and "burn" the load, resulting in clinker production. Although the gases do not bypass the precipitator, the unit is not energized until the fire is stabilized. Particulate emissions are above normal until a stable fire is attained. Kiln baghouses are not affected during start-up.

5.2 SHUTDOWN

Shutdowns do not affect emissions from operations equipped with fabric filters. Emissions through kiln precipitators, however, are higher than normal during shutdown. Although the process and conditioning water is shut off, the kiln must be intermittantly turned to prevent warping. Generally, emissions will only occur during and immediately after rotation.

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* Since the start-up time for each kiln varies, values in this range should not be generalized as standard operating practice. Several kilns minimize start-up emissions by using auxiliary preheat burners.

5.3 MALFUNCTIONS

Common malfunctions of control devices, such as mechanical failures of cleaning systems or fabric deterioration, are adequately described by the control device manufacturers. These problems, together with malfunctions of the kiln that have no effect on air contaminants (e.g. refractory deterioration, cylinder warpage) are not discussed here. The following paragraphs briefly describe malfunctions of the kiln and clinker cooler that can cause increased emissions.

Kiln "rings"* result from a layer of clinker progressively building up inside the kiln and decreasing the cross-sectional area at one or several points; these rings either break down naturally or must be blasted off with shotgun shells. When this happens, clinker rolls down the kiln, creating a high particulate emission potential. Emissions from baghouses are increased by variations in pressure brought about by the ring; particulate emissions from precipitator-controlled kilns increase considerably during ring breakdowns.

Feed systems contribute to emissions by feeding raw materials in a non-uniform manner. Transport equipment, delivering an abundance of feed, can raise uncontrolled emissions. Plugged fuel feed systems can cause loss of flame in the kiln; the resulting incomplete fuel oxidation can cause explosions in precipitators and rarely in baghouses.

Exhaust gas leakage ahead of the control device allows emission of portions of uncleaned gas streams to the atmosphere. Fan casings and ducting splice points should be included in routine inspections.

Precipitator spray nozzles, used to precondition flue gases, plug occasionally. Removal and replacement of a nozzle requires 6 to 8 hours.

Precipitator rapping systems can freeze or rap improperly. A buildup of dust reduces the operating voltage and may eventually short out one or more precipitator sections. Repair of hammer and rapper assemblies requires a minimum of 4 hours.

Precipitator collection electrodes warp under high temperatures. Efficiencies are reduced if the distance between the collecting and discharge electrodes varies.

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* Ring formations cannot be defined as malfunctions, but they do not represent normal kiln operation. Ring formation results in an "upset" condition, and an unstable kiln flame.

Bag failures are the major cause of excessive emissions from a baghouse. Replacement bags will bleed until a filter cake builds up on the fabric.

Baghouse preconditioning exhausr nozzles reduce gas temperatures prior to contacting the fabric. Improperly operating cooling systems increase volumes or reduce bag life.

Control device mechanical equipment such as timers, solenoids, and valves, malfunctions occasionally. Moving parts stick, short, or wear out. Isolating improperly working sections is sometimes difficult.

Screw conveyors transporting collected dust from control device hoppers can become inoperable. At such times, particulate matter is re-entrained from overloaded hopper bins.

5.4 RESPONSIBILITIES DURING MALFUNCTIONS

The Federal Register defines malfunctions as follows: "Malfunctions are sudden and unavoidable failures of control or process equipment, or processes that do not operate in a normal or usual manner. Failures that are caused entirely or in part by poor maintenance, careless operation, or any other preventable condition shall not be considered malfunctions."*

Ring breakdowns although not representing normal kiln operation, are predictable and unavoidable steps in the production of clinker. Therefore, ring breakdowns are not classified as malfunctions, and no record of their history is required.

The other incidents just described are considered malfunctions. Records of these and any other incidents leading to increased emissions must be logged. In addition to describing the malfunction, plant personnel should identify time of occurrence, duration, and steps taken to rectify it.

A quarterly report of malfunctions causing emissions higher than those at the time of the performance test is to be submitted to control agencies. If the same malfunction occurs repeatedly, the agency may request the portland cement facility to submit a plan to eliminate the malfunction or may initiate an enforcement action.

Periodic inspections will minimize the chance of breakdowns resulting in higher emissions. Upon detecting worn or faulty equipment, plant personnel should replace the defective parts as soon as possible. It is important, therefore, that each plant maintain an adequate inventory of spare parts.

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* Federal Register, Vol. 38, No. 84.

6.0 PERFORMANCE TEST

This section describes the performance testing of a portland cement plant for compliance with NSPS. Section 6.1 covers the inspector's responsibilities in preparing for the performance test. Section 6.2 discusses the operating conditions under which the process should be tested, and Section 6.3 outlines key operating parameters to be checked. Section 6.4 describes the required emissions data and the inspector's role in observation of emissions testing. An inspection checklist in Section 6.5 summarizes all process and test parameters to be recorded during the performance test.

6.1 PRETEST PROCEDURES

Although the new source performance standards stipulate exact procedures for compliance, facility personnel may misunderstand or not be aware of parts of the regulations. The inspector should therefore arrange a meeting with plant personnel to review details of the standards and the testing procedures prior to the actual performance test. The inspector provides copies of the performance standards at the meeting.

The inspector must ensure that management understands that performance tests are valid only if performed while the facility is operating at representative performance. At this time, the parties should agree on the production rates constituting "representative performance." The inspector should also determine which testing firm is to perform the tests and, if no representative of the firm attends the meeting, contact the firm to ensure that tests are run in accordance with procedures outlined in 40 CFR 60. The chief purpose of the pretest meeting is to outline clearly for all concerned parties the purpose of the tests and the required test procedures.

The inspector must also survey the ductwork for test port locations. If satisfactory sites are unavailable, he should suggest modifications (e.g. stack extensions, flow straighteners) needed to obtain accurate test results. The location of a clean-up area should be agreed upon by all parties prior to the test data. During a tour of the cement plant, the inspector should determine whether additional inspection personnel are required to monitor the process, sampling site, and exhaust stack.

6.2 PROCESS OPERATING CONDITIONS

In order for a cement facility to comply with new source standards, compliance tests must be run under the most severe conditions that would be expected under representative conditions.

Milling, storage, and loading systems

The throughput of raw and finished products must be representative of normal or above-normal operating capacity. Moisture content of raw feed should not be greater than that anticipated for future operation. All transfer points are evaluated at each point whether or not a control device is operating.

Preheater, kiln, and clinker cooler operation

The major cement-producing processes must operate in the usual manner during the particulate tests and opacity reading periods. Many preheaters and kilns are designed to heat material with exhaust gases from other processes. The amounts of introduced air should be consistent with future operation.

Baghouse cleaning cycles must not deviate from regular operating practice. Power input to a precipitator must be within the normal ranges specified by the manufacturer. The kiln and clinker cooler should be running at the desired load for at least one hour before emission tests are started. Process data must be recorded during the stabilization period to ensure that the process is in equilibrium during the performance runs.

6.3 PROCESS OBSERVATIONS

The inspector should observe the process operating conditions just discussed for future reference. These observations will provide a baseline for comparison with operating conditions during later inspections. Also, the observations may indicate reasons for excessive particulate emissions if the source fails to meet the NSPS.

The inspector must check several operating parameters during the performance test. These include kiln feed rate, fabric filter cleaning cycles, and precipitator power input.

For dry process operations, fresh feed is mixed with small quantities of recycled material and conveyed to the kiln. Many portland cement facilities only monitor the fresh feed weight. Kiln compliance, based on the total weight of feed to the kiln, requires an estimate of the percentage of recycled material in the total feed system. These values should be agreed upon by the inspector and cement plant management prior to the performance tests.

Kiln feed rate

Records of kiln feed rates are required to calculate emissions and to compare with standards for kiln and clinker cooler operation. The raw feed supplied to the kiln is monitored in the control room. These monitors must be calibrated prior to the performance test to assure correct kiln feed rates. The inspector must be informed by plant operators when the emission tests commence and finish so that feed rate during the test can be calculated.

For wet process operations, the moisture content of the fuel is required to convert the feed rate to a dry basis. A 500 to 1000 ml grab sample taken every 15 minutes during each run is sufficient to calculate the moisture content of the dry feed.

Fabric filter cleaning cycles

Prolonging the time between successive cleaning cycles increases particulate collection efficiency and reduces controlled emissions. The frequency and duration of reverse air flow, noted during the performance test, is checked with frequencies and cleaning times during subsequent inspections. Some baghouses have automatic reverse air flow which is triggered by the pressure drop.

Precipitator power input

The amounts of current and voltage supplied to the precipitator indicate gas cleaning performance. Many precipitators are equipped with automatic voltage controls, but amperage variations can change ESP performance characteristics. Unfortunately, undetectable parameters (e.g. plate misalignment) can reduce collection efficiencies.

During the production of portland cement, energy is saved by regenerating hot exhaust gases (e.g. clinker cooler exhaust back through the kiln, kiln exhaust recycled to the preheater). Since the regenerated air flow remains constant at all times, emissions are independent of recycled exhaust gases.

6.4 EMISSION TEST OBSERVATIONS

Particulate tests and opacity determinations are conducted by qualified emission testing personnel. The inspector is responsible for ensuring that all pertinent data are collected, that the field procedures and equipment meets CFR, and that the cement operations are run at representative performance during all sampling operations. A qualified EPA technician or engineer reads visible emissions, as described in Part 60.11(b).

The new source standards require emission tests comprised of three particulate runs performed while the kiln and clinker cooler operate at representative performance. The facility should attempt to run the process at a constant rate during the three runs. Each test must cover at least a 1-hour sampling period and process volume of at least 0.85 dscm (30.0 dscf) and 1.15 dscm (40.6 dscf) respectively, for the kiln and clinker cooler. Sampling sites requiring more than 40 traverse points may require longer sampling times, if the meter technician has difficulty recording data for the individual sampling points due to time limitations. Since constant surveillance of a qualified stack sampling team is not appropriate, the inspector should limit his observations to a few major items:

- Record duct dimensions (both inside and outside) and location of sample ports.

- Check the number of ports at the sampling site and examine the ducting for the nearest upstream and downstream obstructions. Ask the crew leader how many total points will be traversed and check with Figure 1.1 in 40 CFR 60 to determine whether the stream will be properly sampled.

- Note whether the crew runs a preliminary traverse, and if so, inquire what nozzle diameter is selected. (Isokinetic sampling is a function of nozzle size).

- Check to ensure that the moisture content of the gas stream is determined by Method 4 or an equivalent method such as drying tubes or volumetric condensers; assumption of the moisture content is not allowed.

- Observe the leak test of the sampling train. The allowable leak rate is given in Method 5. Leakage results in lower concentrations than are actually present. Be next to the dry gas meter during the leak check, note whether the meter hand is moving. (The more the hand is moving, the greater the air leakage.) Leak checks must also be made if the train is disassembled during the run to change a filter or to replace any component.

- Record dry gas meter readings before and after test.

- Record average velocity head and temperatures in ducts during tests.

- If impingers are used during test, observe whether they are bubbling. If they are not, the sampling train is either plugged or disconnected from the pump.

- Check the cleaning procedures for the front half of the train. Careless removal of filters or cleaning of probes will result in lower calculated emissions. Look for broken glass from probes or connectors. Test is void if glass probe was broken during test. If glass connectors are broken in transport from sampling site to clean-up area, test is still valid. Be sure identification labels are properly attached to collection containers. The probe should be brushed and rinsed with acetone thoroughly to remove all particulates. The probe should be visually inspected after cleaning to ascertain that all particulates have been removed.

- Observe gas analysis procedure for determining CO_2. Technician should take at least three samples before averaging readings. Variations greater than 0.5 percent (grab sample) or 0.2 percent (integrated sample) indicate gas mixture was not thoroughly bubbled in reagents. Ask technician or crew leader when new reagents were added to apparatus.

- Check percent isokinetic.

- Determine calibration dates and procedures used to calibrate pitot tube, thermometer, dry gas meter, and manometer orifice.

- Record process parameters during emission tests and opacity readings.

6.5 PERFORMANCE TEST CHECKLIST

The inspector must observe kiln operation and emission tests simultaneously to ensure that valid data are used in determining plant performance. The performance test checklist in Table 6.1 is based upon the observations described earlier. If the inspector observes any additional parameters the plant records that are directly related to emissions, they should also be recorded.

In the event of a malfunction or upset, the enforcement officer must inform the test crew leader that the sampling trains are to be shut-off and removed from the ducts as quickly as possible. If process changes or deviations occur, the inspector is responsible for instructing the sampling personnel whether to proceed with the run or temporarily stop the test.

The enforcement officer keeps a log of any abnormal operation, time of occurance, and return to representative conditions. After reviewing emission test results, he can decide whether the run is valid.

According to 60.8(a) of 40 CFR 60, cement plant management is responsible for furnishing the Environmental Protection Agency a written report of the results of the emission tests. Appendix B provides a suggested format for the report. These reports should be carefully checked and the data compared with values on the inspection checklist.

Table 6.1 NSPS INSPECTION CHECKLIST: PERFORMANCE TEST OF PORTLAND CEMENT PLANTS

Facility name _____

Facility address _____

Name of plant contact _____

Source code number (indicate CDS, NEDS, etc.) _____

Unit identification (To be tested) _____

Finish grinding rate _____ tons/hour

Kiln input capacity _____ tons/hour

Initial start-up date _____

Test date _____

A. FACILITY DATA

Kiln ☐ Wet

☐ Dry

Major Emission Points

Kiln ☐ Separate Stack Combined with _____

Clinker Cooler ☐ Separate Stack Combined with _____

B. PORTLAND CEMENT PARAMETERS

Record the following data every 30 minutes during performance test.

Parameter	Time				
Kiln feed rate, tons/hr					
Kiln precipitator current,[a] kv					
Kiln baghouse cleaning interval, min.					
Clinker cooler baghouse cleaning interval, min.					

[a]Note for each section.

C. PRETEST DATA (OBTAIN FROM TEST TEAM LEADER)

Test company _____

Field leader _____

Duct dimensions _____ in.x _____ in.; Area _____ ft^2

Nearest upstream obstruction _____ _____ ft

Nearest downstream obstruction _____ ft

No. of sampling ports _____

No. of sampling points _____

No. of sampling points required from Figure 1.1 in 40 CFR 60 _____

D. PARTICULATE PERFORMANCE TEST

Test No. _____ Start time _____ Finish time _____

	Yes	No
Preliminary traverse run (Method 1) Chosen nozzle diameter _____in.	☐	☐
Train leak check	☐	☐

Moisture determination (Method 4)

Percent moisture _____

ml collected gas volume _____ml _____ft^3
(or wet/dry bulb readings)

Combustion gas analysis O_2 _____%

CO_2 _____%

Dry gas meter reading before test _____ft^3 at _____(time)

Dry gas meter reading after test _____ft^3 at _____(time)

Volume sampled _____ft^3

Test duration _____minutes

Average of meter orifice pressure drop _____inches of water

Average duct temperature _____°F

☐ Acceptable ☐ Unacceptable

Velocity Head at Sampling Point _____inches H_2O

Meter ΔH@* _____

Repetition State Time _____

Repetition Finish Time _____

E. CLEAN UP PROCEDURE

Filter condition	☐ Dry	☐ Wet	
Probes	☐ Unbroken	☐ Broken	
Glass connectors	☐ Unbroken	☐ Broken	
Clean up sample spillage	☐ None	☐ Slight	☐ Major
Sample bottle identification	☐ Yes	☐ No	
Acetone blank taken	☐ Yes	☐ No	

F. OPACITY MEASUREMENTS DURING PERFORMANCE TESTS

	Yes	No	Remarks
Transfer points[a]	☐	☐	_____
Crushers	☐	☐	_____
Raw feed mills	☐	☐	_____
Raw feed silos	☐	☐	_____
Preheater	☐	☐	_____
Kiln	☐	☐	_____
Clinker cooler	☐	☐	_____
Clinker cooler silos	☐	☐	_____
Finish grinding mills	☐	☐	_____
Cement storage silos	☐	☐	_____
Loading points	☐	☐	_____

[a]Enforcement officer is responsible for seeing that all transfer points are monitored.

7.0 PROCEDURES FOR PERIODIC INSPECTION

Periodic inspections of a portland cement facility are made to determine whether emissions during routine operation are in compliance with the new source performance standards. Section 7.1 discusses conduct of following the performance test; Section 7.2 provides an inspection checklist. Section 7.3 describes follow-up procedures after completion of an inspection.

7.1 CONDUCT OF INSPECTIONS

Frequency of inspections is governed by agency policy and EPA guidelines. A quarterly inspection is recommended unless complaints dictate more frequent inspections.

Major emphasis of the inspection is upon visual observation of the stack and other emission sources and checking of records and instrumentation. Visible emissions are stressed because enforceable standards can be applied and because they are indicative of control system operation. The inspector also checks operating records, comparing operating hours and kiln feed rates recorded during the performance test with current values. Unfortunately so many process variables affect the efficiency of kilns and clinker coolers equipped with baghouses that pressure drop across the fabric is an unreliable indicator of collection performance. In kilns controlled with precipitators, a power loss (decrease in voltage or current) indicates a possible rise in dust emission.

The inspection procedures noted below should be followed in the order given whenever possible. Any questionable matters can be investigated later by examining records and consulting with facility personnel.

Visible Emissions

- Note opacities of emissions from all processes. Follow established procedures as described by the CFR (Reference Method 9). An observation form is presented in Appendix C.

Control Equipment

- Make a general inspection of all control equipment, with main emphasis on kiln and clinker cooler.

- Inspect interior of kiln and clinker cooler positive pressure baghouses for broken or removed bags. (Negative pressure baghouses cannot readily be internally inspected with the kiln in operation.)

- Check manometers for bag cleaning cycle. Manometer will indicate reverse flow during cleaning. If bags are being cleaned more frequently than during the performance tests, emissions may be higher.

- Record current and voltage inputs to precipitators. If the unit is equipped with a spark rate meter, record the sparks per minute.

Process

- Inspect kiln exterior for warped surfaces or bulges. This can result in refractory damage, causing increased uncontrolled emissions.

Records

- Review feed rates to the kiln and clinker cooler. Increases in feed rate tend to raise particulate emissions, unless additional control devices are added. If feed rates are consistently higher than those at the time of the performance test, another emission test is warranted.

- When opacity-measuring instruments are installed on kiln exhaust systems, examine the printout graphs fpr steady-state opacity values and frequency of malfunctions.

7.2 INSPECTION CHECKLIST

The inspection checklist in Table 7.1 is derived from the procedures just described.

7.3 INSPECTION FOLLOW-UP PROCEDURES

The inspector should be affiliated with either a federal, state, or local agency. In any event he should be aware of the importance of interagency communications among all groups concerned with the current status of new or modified portland cement plants.

Some inspectors may have responsibility for monitoring of air pollutants in addition to those covered by the NSPS, such as odors and fugitive dust emissions. The inspector's supervisor or other agency official will determine whether monitoring of the additional pollutants is handled separately or in combination with those covered by the NSPS.

Table 7.1 NSPS INSPECTION CHECKLIST:

PERIODIC CHECK OF PORTLAND CEMENT PLANT

Facility name _____

Facility address _____

Name of plant contact _____

Source code number _____

Inspection date _____

A. VISIBLE EMISSIONS

	Opacity Compliance		
	IN	OUT	Remarks
Transfer points[a]	☐	☐	_____
Crushers	☐	☐	_____
Raw feed mills	☐	☐	_____
Raw Feed silos	☐	☐	_____
Kiln	☐	☐	_____
Clinker cooler	☐	☐	_____
Clinker cooler silos	☐	☐	_____
Finish grinding mills	☐	☐	_____
Cement storage silos	☐	☐	_____
Loading points	☐	☐	_____

[a]Note opacities from all transfer points

B. CONTROL EQUIPMENT

Control	Preheater	Kiln	Clinker cooler
Baghouse: filter cleaning interval, min.	_____	____	_____
Precipitator: power input - voltage, kv	_____	____	_____
current, ma	_____	____	_____

Note any processes with improper operation, (e.g. inoperative fan, missing or broken bags, exhaust bypass, dirty hoppers, inadequate hoods.)

Operation	Description of malfunction
_____	_____
_____	_____
_____	_____
_____	_____

C. PROCESS

Exterior condition of kiln:

☐ Cylindrical

☐ Warped

D. RECORDS

Parameter	Records kept: Yes	No
Kiln feed rate	☐	☐
Cement production rate[a]	☐	☐
Particulate emission measurements	☐	☐
Malfunction episodes	☐	☐

[a] Emissions are independent of daily cement production, but 40 CFR 60 requires the records be kept.

The sequence for any required enforcement action is as follows. Using the inspection checklist (Table 7.1), the inspector prepares a report of the status of the portland cement facility. Legal and technical authorities review the report to determine whether a citation or another performance test is in order. In cases requiring court action, the inspector may be called on to testify and will have need for accurate, dated records of his observations.

The inspector should also compare the current inspection data with data from earlier inspections or from the performance test. Although compliance with particulate emission standards cannot be determined without a source test, the checklists should provide sufficient information to indicate whether the facility may be generating excessive particulate emissions, and whether the facility is adhering to good maintenance practices. Table 7.2 provides a comparison guideline by which the inspector can determine when to recommend enforcement action, such as issuance of a citation or conduct of compliance tests.

Table 7.2 GUIDELINES FOR COMPARATIVE EVALUATION OF COMPLIANCE STATUS

Parameter	Indicators for enforcement action
Visible emissions	When opacity readings are greater than allowable values, allow reasonable time for control (24 hours to 30 days, depending on task and availability of parts) before recommending citation.
Kiln feed rate	A 1-hour average greater than 120% of kiln feed rate over rate recorded during performance test occurring more than once per week warrants request for emission tests of kiln and clinker cooler.
Control equipment	Kiln precipitator: Power decrease of 20% or more warrants emission tests at that rating. Kiln and clinker cooler baghouse: When intervals between cleaning decrease by more than 50% (based on performance test), request emission tests.

APPENDIX A

STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

CODE OF FEDERAL REGULATIONS

(See 40 CFR 60 for complete sampling procedures)

CFR Title 40 – PROTECTION OF ENVIRONMENT

Chapter 1 - Environmental Protection Agency

SUBCHAPTER C - AIR PROGRAMS

PART 60 - STANDARDS OF PERFORMANCE
FOR NEW STATIONARY SOURCES

Subpart A - General Provisions

§ 60.1 Applicability.

The provisions of this part apply to the owner or operator of any stationary source which contains an affected facility the construction or modification of which is commenced after the date of publication in this part of any standard (or, if earlier, the date of publication of any proposed standard) applicable to such facility.

§ 60.2 Definitions.

As used in this part, all terms not defined herein shall have the meaning given them in the Act:

(a) "Act" means the Clean Air Act (42 U.S.C. 1857 et seq., as amended by Public Law 91-604, 84 Stat. 1676).

(b) "Administrator" means the Administrator of the Environmental Protection Agency or his authorized representative.

(c) "Standard" means a standard of performance proposed or promulgated under this part.

(d) "Stationary source" means any building, structure, facility, or installation which emits or may emit any air pollutant.

(e) "Affected facility" means, with reference to a stationary source, any apparatus to which a standard is applicable.

(f) "Owner or operator" means any person who owns, leases, operates, controls, or supervises an affected facility or a stationary source of which an affected facility is a part.

(g) "Construction" means fabrication, erection, or installation of an affected facility.

(h) "Modification" means any physical change in, or change in the method of operation of, an affected facility which increases the amount of any air pollutant (to which a standard applies) emitted by such facility or which results in the emission of any air pollutant (to which a standard applies) not previously emitted, except that:

(1) Routine maintenance, repair, and replacement shall not be considered physical changes, and

(2) The following shall not be considered a change in the method of operation:

(i) An increase in the production rate, if such increase does not exceed the operating design capacity of the affected facility;

(ii) An increase in hours of operation;

(iii) Use of an alternative fuel or raw material if, prior to the date any standard under this part becomes applicable to such facility, as provided by § 60.1, the affected facility is designed to accomodate such alternative use.

(i) "Commenced" means, with respect to the definition of "new source" in section 111(a)(2) of the Act, that an owner or operator has undertaken a continuous program of construction or modification or that an owner or operator has entered into a contractual obligation to undertake and complete, within a reasonable time, a continuous program of construction or modification.

(j) "Opacity" means the degree to which emissions reduce the transmission of light and obscure the view of an object in the background.

(k) "Nitrogen oxides" means all oxides of nitrogen except nitrous oxide, as measured by test methods set forth in this part.

(l) "Standard conditions" means a temperature of 20°C (68°F) and a pressure of 760 mm of Hg (29.92 in. of Hg).

(m) "Proportional sampling" means sampling at a rate that produces a constant ratio of sampling rate to stack gas flow rate.

(n) "Isokinetic sampling" means sampling in which the linear velocity of the gas entering the sampling nozzle is equal to that of the undisturbed gas stream at the smaple point.

(o) "Start-up" means the setting in operation of an affected facility for any prupose.

(p) "Shutdown" means the cessation of operation of an affected facility for any purpose.

(q) "Malfunction" means any sudden and unavoidable failure of air pollution control equipment or process equipment or of a process to operate in a normal or usual manner. Failures that are caused entirely or in part by poor maintenance, careless operation, or any other preventable upset condition or preventable equipment breakdown shall not be considered malfunctions.

(r) "Hourly period" means any 60 minute period commencing on the hour.

(s) "Reference method" means any method of sampling and analyzing for an air pollutant as described in Appendix A to this part.

(t) "Equivalent method" means any method of sampling and analyzing for an air pollutant which have been demonstrated to the Administrator's satisfaction to have a consistent and quantitatively known relationship to the reference methods, under specified conditions.

(u) "Alternative method" means any method of sampling and analyzing for an air pollutant which is not a reference or equivalent method but which has been demonstrated to the Administrator's satisfaction to, in specific cases, produce results adequate for his determination of compliance.

(v) "Particulate matter" means any finely divided solid or liquid material, other than uncombined water, as measured by Method 5 of Appendix A to this part or an equivalent or alternative method.

(w) "Run" means the net period of time during which an emission sample is collected. Unless otherwise specified, a run may be either intermittent or continuous within the limits of good engineering practice.

§ 60.4 Address.

All requests, applications, submittals, and other communications to the Administrator pursuant to this part shall be submitted in duplicate and addressed to the appropriate Regional Office of the Environmental Protection Agency, to the attention of the Director, Enforcement Division.

§ 60.5 Determination of construction or modification.

When requested to do so by an owner or operator, the Administrator will make a determination of whether actions taken or intended to be taken by such owner or operator constitute construction or modification or the commencement thereof within the meaning of this part.

§ 60.6 Review of plans.

(a) When requested to do so by an owner or operator, the Administrator will review plans for construction or modification for the purpose of providing technical advice to the owner or operator.

(b)(1) A separate request shall be submitted for each construction or modification project.

(2) Each request shall identify the location of such project, and be accompanied by technical information describing the proposed nature, size, design, and method of operation of each affected facility involved in such project, including information on any equipment to be used for measurement or control of emissions.

(c) Neither a request for plans review nor advice furnished by the Administrator in response to such request shall (1) relieve an owner or operator of legal responsibility for compliance with any provision of this part or of any applicable State or local requirement, or (2) prevent the Administrator from implementing or enforcing any provision of this part or taking any other action authorized by the Act.

§ 60.7 Notification and record keeping.

(a) Any owner or operator subject to the provisions of this part shall furnish the Administrator written notification as follows:

(1) A notification of the anticipated date of initial start-up of an affected facility not more than 60 days or less than 30 days prior to such date.

(2) A notification of the actual date of initial start-up of an affected facility within 15 days after such date.

(b) Any owner or operator subject to the provisions of this part shall maintain for a period of 2 years a record of the occurrence and duration of any start-up, shutdown, or malfunction in operation of any affected facility.

(c) A written report of excess emissions as defined in applicable subparts shall be submitted to the Administrator by each owner or operator for each calendar quarter. The report shall include the magnitude of excess emissions as measured by the required monitoring equipment reduced to the units of the applicable standard, the date, and time of commencement and completion of each period of excess emissions. Periods of excess emissions due to start-up, shutdown, and malfunction shall be specifically identified. The nature and cause of any malfunction (if known), the corrective action taken, or preventive measures adopted shall be reported. Each quarterly report is due by the 30th day following the end of the calendar quarter. Reports are not required for any quarter unless there have been periods of excess emissions.

(d) Any owner or operator subject to the provisions of this part shall maintain a file of all measurements, including monitoring and performance testing measurements, and all other reports and records required by all applicable subparts. Any such instruments, reports and records shall be retained for at least 2 years following the date of such measurements, reports, and records.

§ 60.8 Performance tests.

(a) Within 60 days after achieving the maximum production rate at which the affected facility will be operated, but not later than 180 days after initial start-up of such facility and at such other times as may be required by the

Administrator under section 114 of the Act, the owner or operator of such facility shall conduct performance test(s) and furnish the Administrator with a written report of the results of such performance test(s).

(b) Performance tests shall be conducted and data reduced in accordance with the test methods and procedures contained in each applicable subpart unless the Administrator (1) specifies or approves, in specific cases, the use of a reference method with minor changes in methodology, (2) approves the use of an equivalent method, (3) approves the use of an alternative method the results of which he has determined to be adequate for indicating whether a specific source is in compliance, or (4) waives the requirement for performance tests because the owner or operator of a source has demonstrated by other means to the Administrator's satisfaction that the affected facility is in compliance with the standard. Nothing in this paragraph shall be construed to abrogate the Administrator's authority to require testing under section 114 of the Act.

(c) Performance tests shall be conducted under such conditions as the Administrator shall specify to the plant operator based on representative performance of the affected facility. The owner or operator shall make available to the Administrator such records as may be necessary to determine the conditions of the performance tests. Operations during periods of start-up, shutdown, and malfunction shall not constitute representative conditions of performance tests unless otherwise specified in the applicable standard.

(d) The owner and operator of an affected facility shall provide the Administrator 30 days prior notice of the performance test to afford the Administrator the opportunity to have an observer present.

(e) The owner or operator of an affected facility shall provide or cause to be provided, performance testing facilities as follows:

(1) Sampling ports adequate for test methods applicable to such facility.

(2) Safe sampling platform(s).

(3) Safe access to sampling platform(s).

(4) Utilities for sampling and testing equipment.

(f) Each performance test shall consist of three separate runs using the applicable test method. Each run shall be conducted for the time and under the conditions specified in the applicable standard. For the purpose of determining compliance with an applicable standard, the arithmetic means of results of the three runs shall apply. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of forced shutdown, failure of an irreplacable portion of the sample train, extreme meteorological conditions, or other circumstances, beyond the owner or operator's control, compliance may, upon the Administrator's approval, be determined using the arithmetic mean of the results of the two other runs.

§ 60.9 Availability of information.

(a) Emission data provided to, or otherwise obtained by, the Administrator in accordance with the provisions of this part shall be available to the public.

(b) Except as provided in paragraph (a) of this section, any records, reports, or information provided to, or otherwise obtained by, the Administrator in accordance with the provisions of this part shall be available to the public, except that (1) upon a showing satisfactorily to the Administrator by any person that such records, reports, or information, or particular part thereof (other than emission data), if made public, would divulge methods or processes entitled to protection as trade secrets of such person, the Administrator shall consider such records, reports, or information, or particular part thereof, confidential in accordance with the purposes of section 1905 of title 18 of the United States Code, except that such records, reports, or information, or particular part thereof, may be disclosed to other officers, employees, or authorized representatives of the United States concerned with carrying out the provisions of the Act or when relevant in any proceeding under the Act; and (2) information received by the Administrator solely for the purposes of § 60.5 and 60.8 shall not be disclosed if it so identified by the owner or operator as being a trade secret or commercial or financial information which such owner or operator considers confidential.

§ 60.10 State authority.

The provisions of this part shall not be construed in any manner to preclude any State or political subdivision thereof from:

(a) Adopting and enforcing any emission standard or limitation applicable to an affected facility, provided that such emission standard or limitation is not less stringent than the standard applicable to such facility.

(b) Requiring the owner or operator of an affected facility to obtain permits, licenses, or approvals prior to initiating construction, modification, or operation of such facility.

§ 60.11 Compliance with standards and maintenance requirements.

(a) Compliance with standards in this part, other than opacity standards, shall be determined only by performance tests established by § 60.8.

(b) Compliance with opacity standards in this part shall be determined by conducting observations in accordance with Reference Method 9 in Appendix A of this part. Opacity readings of portions of plumes which contain condensed, uncombined water vapor shall not be used for purposes of determining compliance with opacity standards. The results of continuous monitoring by transmissometer which indicate that the opacity at the time visual observations were made was not in excess

of the standard are probative but not conclusive evidence of the actual opacity of an emission, provided that the source shall meet the burden of proving that the instrument used meets (at the time of the alleged violation) Performance Specification 1 in Appendix B of this part, has been properly maintained and (at the time of the alleged violation) calibrated, and that the resulting data have not been tampered with in any way.

(c) The opacity standards set forth in this part shall apply at all times except during periods of start-up, shutdown, or malfunction, and as otherwise provided in the applicable standard.

(d) At all times, including periods of start-up, shutdown, and malfunction, owners and operators shall, to the extent practicable, maintain and operate any affected facility including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Administrator which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source.

(e)(1) An owner or operator of an affected facility may request the Administrator to determine opacity of emissions from the affected facility during the initial performance tests required by § 60.8.

(2) Upon receipt from such owner or operator of the written report of the results of the performance tests required by § 60.8, the Administrator will make a finding concerning compliance with opacity and other applicable standards. If the Administrator finds that an affected facility is in compliance with all applicable standards for which performance tests are conducted in accordance with § 60.8 of this part but during the time such performance tests are being conducted fails to meet any applicable opacity standard, he shall notify the owner or operator and advise him that he may petition the Administrator within 10 days of receipt of notification to make appropriate adjustment to the opacity standard for the affected facility.

(3) The Administrator will grant such a petition upon a demonstration by the owner or operator that the affected facility and associated air pollution control equipment was operated and maintained in a manner to minimize the opacity of emissions during the performance tests; that the performance tests were performed under the conditions established by the Administrator; and that the affected facility and associated air pollution control equipment were incapable of being adjusted or operated to meet the applicable opacity standard.

(4) The Administrator will establish an opacity standard for the affected facility meeting the above requirements at a level at which the source will be able, as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source is meeting the mass or concentration emission standard. The Administrator will promulgate the new opacity standard in the Federal Register.

§ 60.12 Circumvention.

No owner or operator subject to the provisions of this part shall build, erect, install, or use any article, machine, equipment or process, the use of which conceals an emission which would otherwise constitute a violation of an applicable standard. Such concealment includes, not is not limited to, the use of gaseous diluents to achieve compliance with an opacity standard or with a standard which is based on the concentration of a pollutant in the gases discharged to the atmosphere.

Subpart F - Standards of Performance for Portland Cement Plants

§ 60.60 Applicability and designation of affected facility.

The provisions of the subpart are applicable to the following affected facilities in portland cement plants; kiln, clinker cooler, raw mill dryer, raw material storage, clinker storage, finished product storage, conveyor transfer points, bagging and bulk loading and unloading systems.

§ 60.61 Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Act and in Subpart A of this part.

(a) "Portland cement plant" means any facility manufacturing portland cement by either the wet or dry process.

§ 60.62 Standard for particulate matter.

(a) On and after the date on which the performance test required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from any kiln any gases which:

(1) Contain particulate matter in excess of 0.15 kg per metric ton of feed (dry basis) to the kiln (0.30 lb per ton).

(2) Exhibit greater than 20 percent opacity.

(b) On and after the date on which the performance test is required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from any clinker cooler any gases which:

(1) Contain particulate matter in excess of 0.050 kg per metric ton of feed (dry basis) to the kiln (0.10 lb per ton).

(2) Exhibit 10 percent opacity, or greater.

(c) On and after the date on which the performance test required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause

to be discharged into the atmosphere from any affected facility other than the kiln and clinker cooler any gases which exhibit 10 percent opacity, or greater.

§ 60.63 Monitoring of operations.

(a) The owner or operator of any portland cement plant subject to the provisions of this part shall record the daily production rates and kiln feed rates.

§ 60.64 Test methods and procedures.

(a) The reference methods in Appendix A to this part, except as provided for in § 60.8(b), shall be used to determine compliance with the standards prescribed in § 60.62 as follows:

(1) Method 5 for the concentration of particulate matter and the associated moisture content;

(2) Method 1 for sample and velocity traverses;

(3) Method 2 for velocity and volumetric flow rate; and

(4) Method 3 for gas analysis.

(b) For Method 5, the minimum sampling time and minimum sample volume for each run, except when process variables or other factors justify otherwise to the satisfaction of the Administrator, shall be as follows:

(1) 60 minutes and 0.85 dscm (30.0 dscf) for the kiln.

(2) 60 minutes and 1.15 dscm (40.6 dscf) for the clinker cooler.

(c) Total kiln feed rate (except fuels), expressed in metric tons per hour on a dry basis, shall be determined during each testing period by suitable methods; and shall be confirmed by a material balance over the production system.

(d) For each run, particulate matter emissions, expressed in g/metric ton of kiln feed, shall be determined by dividing the emission rate in g/hr by the kiln feed rate. The emission rate shall be determined by the equation, $g/hr = Q_s \times c$, where Q_s equals the volumetric flow rate of the total effluent in dscm/hr as determined in accordance with paragraph (a)(3) of this section, and c equals particulate concentration in g/dscm as determined in accordance with paragraph (a)(1) of this section.

APPENDIX - TEST METHODS

Method 1 - Sample and Velocity Traverses For Stationary Sources

1. Principle and Applicability

1.1 Principle. A sampling site and the number of traverse points are selected to air in the extraction of a representative sample.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

2. Procedure

2.1 Selection of a sampling site and minimum number of traverse points.

2.1.1 Select a sampling site that is at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, contraction, or visible flame. For rectangular cross section, determine an equivalent diameter from the following equation:

$$\text{equivalent diameter} = 2\left(\frac{(\text{length})(\text{width})}{\text{length} + \text{width}}\right) \qquad \text{equation 1-1}$$

2.1.2 When the above sampling site criteria can be met, the minimum number of traverse points is twelve (12).

2.1.3 Some sampling situations render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use Figure 1-1 to determine the minimum number of traverse points. Under no conditions should a sampling point be selected within 1 inch of the stack wall. To obtain the number of traverse points for stacks or ducts with a diameter less than 2 feet, multiply the number of points obtained from Figure 1-1 by 0.67.

2.1.4 To use Figure 1-1 first measure the distance from the chosen sampling location to the nearest upstream and downstream disturbances. Determine the corresponding number of traverse points for each distance from Figure 1-1.

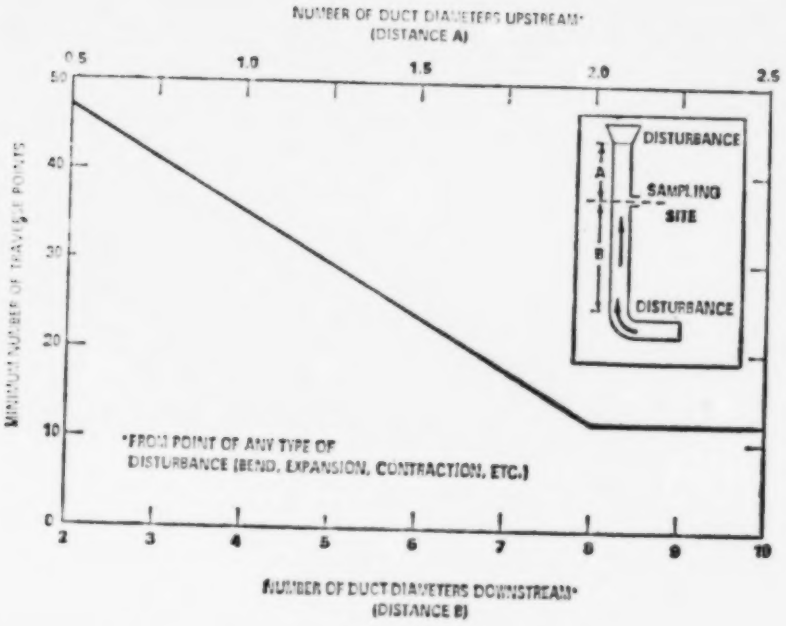


Figure 1-1. Minimum number of traverse points.

Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of 4, and for rectangular stacks the number follows the criteria of section 2.2.2.

2.2 Cross-sectional layout and location of traverse points.

2.2.1 For circular stacks locate the traverse points on at least two diameters according to Figure 1-2 and Table 1-1. The traverse axes shall divide the stack cross section into equal parts.

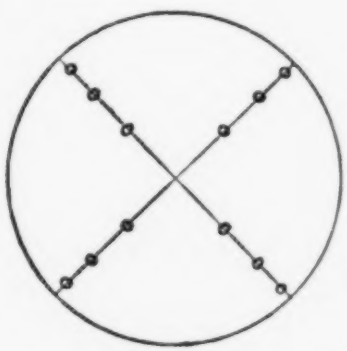


Figure 1-2. Cross section of circular stack divided into 12 equal areas, showing location of traverse points at centroid of each area.

Table 1-1. Location of traverse points in circular stacks (Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	89.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

2.2.2 For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area according to Figure 1-3.

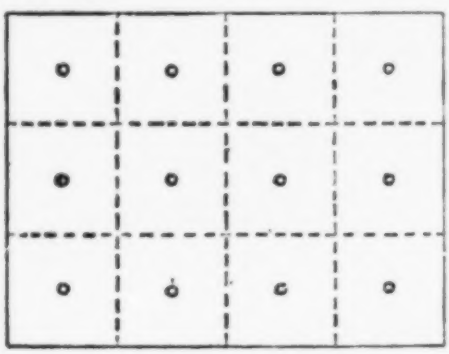


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

3. References

Determining Dust Concentration in a Gas Stream, ASME Performance Test Code #27, New York, N.Y., 1957.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, California, November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, California, Bulletin WP-50, 1968.

Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pennsylvania, 1971, ASTM Designation D-2928-71.

Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

1. Principle and applicability

1.1 Principle. Stack gas velocity is determined from the gas density and from measurement of the velocity head using a Type S (Stauscheibe or reverse type) pitot tube.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards.

2. Apparatus

2.1 Pitot tube - Type S (Figure 2-1), or equivalent, with a coefficient within $\pm 5\%$ over the working range.

2.2 Differential pressure gauge - Inclined manometer, or equivalent, to measure velocity head to within 10% of the minimum value.

2.3 Temperature gauge - Thermocouple or equivalent attached to the pitot tube to measure stack temperature to within 1.5% of the minimum absolute stack temperature.

2.4 Pressure gauge - Mercury-filled U-tube manometer, or equivalent, to measure stack pressure to within 0.1 in. Hg.

2.5 Barometer - To measure atmospheric pressure to within 0.1 in. Hg.

2.6 Gas analyzer - To analyze gas composition for determining molecular weight.

2.7 Pitot tube - Standard type, to calibrate Type S pitot tube.

3. Procedure

3.1 Set up the apparatus as shown in Figure 2-1. Make sure all connections are tight and leak free. Measure the velocity head and temperature at the traverse points specified by Method 1.

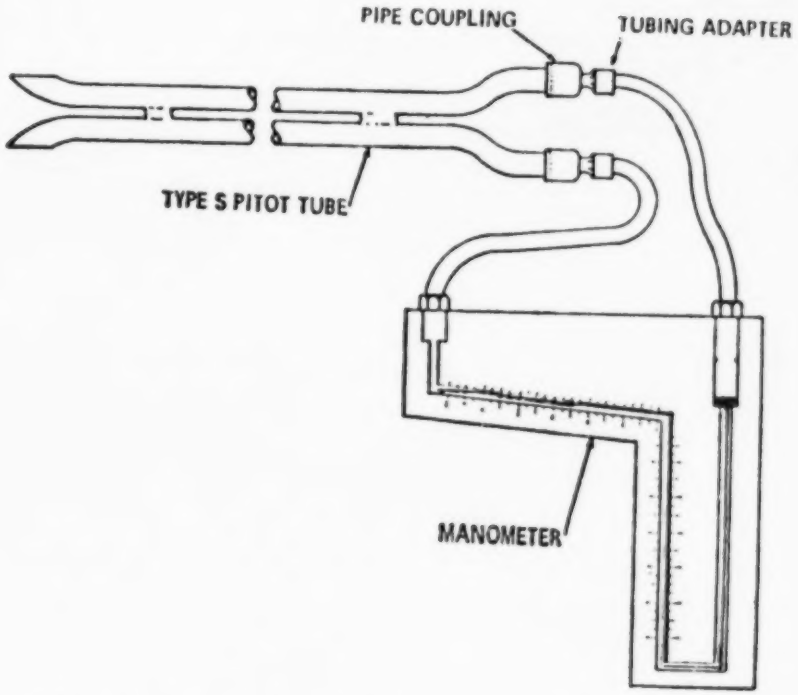


Figure 2-1. Pitot tube-manometer assembly.

3.2 Measure the static pressure in the stack.

3.3 Determine the stack gas molecular weight by gas analysis and appropriate calculations as indicated in Method 3.

4. Calibration

4.1 To calibrate the pitot tube, measure the velocity heat at some point in a flowing gas stream with both a Type S pitot tube and a standard type pitot tube with known coefficient. Calibration should be done in the laboratory and the velocity of the flowing gas stream should be varied over the normal working range. It is recommended that the calibration be repeated after use at each field site.

4.2 Calculate the pitot tube coefficient using equation 2-1.

$$C_{p_{test}} = C_{p_{std}} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}} \qquad \text{equation 2-I}$$

where:

$C_{p_{test}}$ = Pitot tube coefficient of Type S pitot tube.

$C_{p_{std}}$ = Pitot tube coefficient of standard type pitot tube (if unknown, use 0.99)

Δp_{std} = Velocity head measured by standard type pitot tube.

Δp_{test} = Velocity head measured by Type S pitot tube.

4.3 Compare the coefficients of the Type S pitot tube determined first with one leg and then the other pointed downstream. Use the pitot tube only if the two coefficients differ by no more than 0.01.

5. Calculations

Use equation 2-2 to calculate the stack gas velocity.

$$(V_s)_{avg.} = K_p C_p (\sqrt{\Delta p})_{avg.} \sqrt{\frac{(T_s)_{avg.}}{P_s M_s}} \qquad \text{equation 2-2}$$

where:

$(V_s)_{avg.}$ = Stack gas velocity, feet per second (f.p.s.)

$K_p = 85.48 \frac{ft.}{sec.} \left(\frac{lb.}{lb.mole-°R}\right)^{1/2}$ when these units are used.

C_p = Pitot tube coefficient, dimensionless.

$(T_s)_{avg.}$ = Average absolute stack gas temperature, °R.

$(\sqrt{\Delta p})_{avg.}$ = Average velocity head of stack gas, inches H_2O (see Figure 2-2).

P_s = Absolute velocity head of stack gas (wet basis), lb/lb-mole.

M_s = Molecular weight of stack gas (wet basis), lb./lb.-mole $M_d(1-B_{wo})+18B_{wo}$

M_d = Dry molecular weight of stack gas (from Method 3).

B_{wo} = Proportion by volume of water vapor in the gas stream (from Method 4).

Figure 2-2 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of Figure 2-2 to determine the average stack gas velocity from Equation 2-2.

PLANT _____

DATE _____

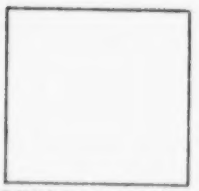
RUN NO _____

STACK DIAMETER, in _____

BAROMETRIC PRESSURE, in. Hg _____

STATIC PRESSURE IN STACK (P_g), in. Hg _____

OPERATORS _____



SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_p}$	Stack Temperature (T_S), °F
	AVERAGE:		

Figure 2-2. Velocity traverse data.

Use Equation 2-3 to calculate the stack gas volumetric flow rate.

$$Q_s = 3600\,(1 - B_{wo})V_s A \left(\frac{T_{std}}{(T_s)_{avg.}}\right)\left(\frac{P_s}{P_{std}}\right) \qquad \text{equation 2-3}$$

where:

Q_s = Volumetric flow rate, dry basis, standard conditions, ft.^{3}/hr.

A = Cross-sectional area of stack, ft^2

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6. References

Mark, L. S., Mechanical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1951.

Perry, J. H., Chemical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

Shigehara, R. T., W. F. Todd, and W. S. Smith, Significance of Errors in Stack Sampling Measurements. Paper presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Missouri, June 14-19, 1970.

Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pennsylvania, 1971, ASTM Designation D-2928-71.

Vennard J. D., Elementary Fluid Mechanics, John Wiley & Sons, Inc., New York, N.Y., 1947.

Method 3 - Gas Anaylsis for Carbon Dioxide, Excess Air, and Dry Molecular Weight

1. Principle and applicability

1.1 Principle. An integrated or grab gas sample is extracted from a sampling point and analyzed for its components using an Orsat analyzer.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. The test procedure will indicate whether a grab sample or an integrated sample is to be used.

2. Apparatus

2.1 Grab sample (Figure 3-1).

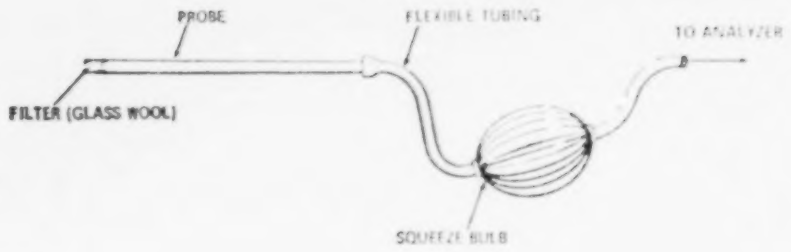


Figure 3-1. Grab-sampling train.

2.1.1 Probe - Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.1.2 Pump - One-way squeeze bulb, or equivalent, to transport gas sample to analyzer.

2.2 Integrated sample (Figure 3-2).

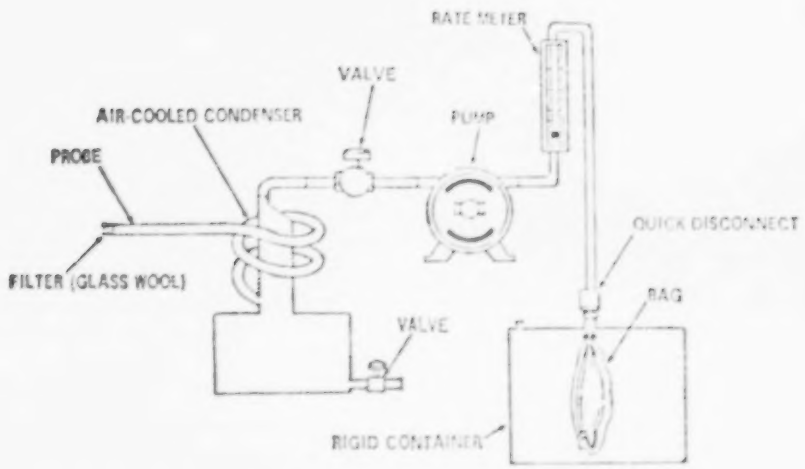


Figure 3-2. Integrated gas - sampling train.

2.2.1 Probe - Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.2.2 Air-cooled condenser or equivalent - To remove any excess moisture.

2.2.3 Needle valve - To adjust flow rate.

2.2.4 Pump - Leak-free, diaphragm type, or equivalent, to pull gas.

2.2.5 Rate meter - To measure a flow range from 0 to 0.035 cfm.

---

[1] Trade name.

2.2.6 Flexible bag - Tedlar,[1] or equivalent, with a capacity of 2 to 3 cu. ft. Leak test the bag in the laboratory before using.

2.2.7 Pitot tube - Type S, or equivalent, attached to the probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

2.3 Analysis

2.3.1 Orsat analyzer, or equivalent.

3. Procedure

3.1 Grab sampling

3.1.1 Set up the equipment as shown in Figure 3-1, making sure all connections are leak-free. Place the probe in the stack at a sampling point and purge the sampling line.

3.1.2 Draw sample into the analyzer.

3.2 Integrated Sampling

3.2.1 Evacuate the flexible bag. Set up the equipment as shown in Figure 3-2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are tight and that there are no leaks.

3.2.2 Sample at a rate proportional to the stack velocity.

3.3 Analysis

3.3.1 Determine the CO_2, O_2, and CO concentrations as soon as possible. Make as many passes as are necessary to give constant readings. If more than ten passes are necessary, replace the absorbing solution.

3.3.2 For grab sampling, repeat the sampling and analysis until three consecutive samples vary no more than 0.5 percent by volume for each component being analyzed.

3.3.3 For integrated sampling, repeat the analyses of the sample until three consecutive analyses vary no more than 0.2 percent by volume for each component being analyzed.

4. Calculations

4.1 Carbon dioxide. Average the three consecutive runs and report the results to the nearest 0.1% CO_2.

4.2 Excess air. Use Equation 3-1 to calculate excess air, and average the runs. Report the result to the nearest 0.1% excess air.

$$\%EA = \frac{(\%O_2) - 0.5(\%CO)}{0.264(\%N_2) - (\%O_2) + 0.5(\%CO)} \times 100 \qquad \text{equation 3-1}$$

[1] Trade name.

where:

%EA = Percent excess air.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

%CO = Percent carbon monoxide by volume, dry basis.

0.264 = Ratio of oxygen to nitrogen in air by volume.

4.3 Dry molecular weight. Use Equation 3-2 to calculate dry molecular weight and average the runs. Report the result to the nearest tenth.

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%\,CO) \qquad \text{equation 3-2}$$

where:

M_d = Dry molecular weight, lb./lb-mole.

$\%CO_2$ = Percent carbon dioxide by volume, dry basis.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

0.44 = Molecular weight of carbon dioxide divided by 100.

0.32 = Molecular weight of oxygen divided by 100.

0.28 = Molecular weight of nitrogen and CO divided by 100.

5. References

Altshuller, A. P., et al., Storage of Gases and Vapors in Plastic Bags, Int. J. Air & Water Pollution, 6:75-81, 1963.

Conner, William D., and J. S. Nader, Air Sampling with Plastic Bags, Journal of the American Industrial Hygiene Association, 25:291-297, May-June 1964.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, California, November 1963.

Method 4 - Determination of Moisture in Stack Gases

1. Principle and applicability

1.1 Principle. Moisture is removed from the gas stream, condensed, and determined volumetrically.

1.2 Applicability. This method is applicable for the determination of moisture in stack gas only when specified by test procedures for determining compliance with New Source Performance Standards. This method does not apply when liquid droplets are present in the gas stream[1] and the moisture is subsequently used in the determination of stack gas molecular weight.

Other methods such as drying tubes, wet bulb-dry bulb techniques, and volumetric condensation techniques may be used.

2. Apparatus

2.1 Probe - Stainless steel or Pyrex[2] glass sufficiently heated to prevent condensation and equipped with a filter to remove particulate matter.

2.2 Impingers - Two midget impingers, each with 30 ml. capacity, or equivalent.

2.3 Ice bath container - To condense moisture in impingers.

2.4 Silica gel tube (optional) - To protect pump and dry gas meter.

2.5 Needle valve - To regulate gas flow rate.

2.6 Pump - Leak-free, diaphragm type, or equivalent, to pull gas through train.

2.7 Dry gas meter - To measure to within 1% of the total sample volume.

2.8 Rotameter - To measure a flow range from 0 to 0.1 c.f.m.

2.9 Graduated cylinder - 25 ml.

2.10 Barometer - Sufficient to read to within 0.1 inch Hg.

2.11 Pitot tube - Type S, or equivalent, attached to probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

---

[1] If liquid droplets are present in the gas stream, assume the stream to be saturated, determine the average stack gas temperature by traversing according to Method 1, and use a psychrometric chart to obtain an approximation of the moisture percentage.

[2] Trade name.

3. Procedure

3.1 Place exactly 5 ml. distilled water in each impinger. Assemble the apparatus without the probe as shown in Figure 4-1. Leak check by plugging the inlet to the first impinger and drawing a vacuum. Insure that flow through the dry gas meter is less than 1% of the sampling rate.

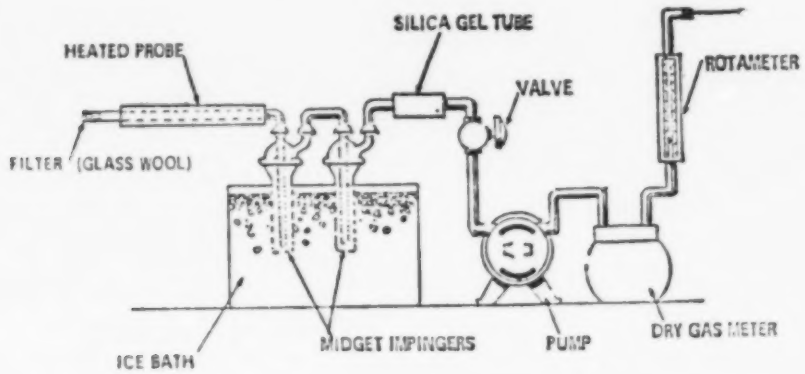


Figure 4-1. Moisture-sampling train.

3.2 Connect the probe and sample at a constant rate of 0.075 c.f.m. or at a rate proportional to the stack gas velocity. Continue sampling until the dry gas meter registers 1 cubic foot or until visible liquid droplets are carried over from the first impinger to the second. Record temperature, pressure, and dry gas meter readings as required by Figure 4-2.

LOCATION_____ COMMENTS

TEST_____

DATE_____

OPERATOR_____

BAROMETRIC PRESSURE_____

CLOCK TIME	GAS VOLUME THROUGH METER, (Vm), ft^3	ROTAMETER SETTING ft^3/min	METER TEMPERATURE, °F

Figure 4-2. Field moisture determination.

3.3 After collecting the sample, measure the volume increase to the nearest 0.5 ml.

4. Calculations

4.1 Volume of water vapor collected.

$$V_{wc} = \frac{(V_f - V_i)\rho_{H_2O} RT_{std}}{P_{std} M_{H_2O}} = 0.0474 \frac{ft.^3}{ml.}(V_f - V_i) \qquad \text{equation 4-1}$$

where:

V_{wc} = Volume of water vapor collected (standard conditions), cu.ft.

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents, ml.

R = Ideal gas constant, 21.83 inches Hg - cu.ft./lb.mole-°R.

ρ_{H_2O} = Density of water, 1 g./ml.

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

4.2 Gas volume.

$$V_{mc} = V_m \left(\frac{P_m}{P_{std}}\right)\left(\frac{T_{std}}{T_m}\right) = 17.71 \frac{°R}{in.\ Hg}\left(\frac{V_m P_m}{T_m}\right) \qquad \text{equation 4-2}$$

where:

V_{mc} = Dry gas volume through meter at standard conditions, cu.ft.

V_m = Dry gas volume measured by meter, cu.ft.

P_m = Barometric pressure at the dry gas meter, inches Hg.

P_{std} = Pressure at standard conditions, 29.92 inches Hg.

T_{std} = Absolute temperature at standard conditions, 530°R.

T_m = Absolute temperature at meter (°F+460), °R.

4.3 Moisture content.

$$B_{wo} = \frac{V_{wc}}{V_{wc} + V_{mc}} + B_{wm} = \frac{V_{wc}}{V_{wc} + V_{mc}} + (0.025) \qquad \text{equation 4-3}$$

where:

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

V_{wc} = Volume of water vapor collected (standard conditions), cu.ft.

V_{mc} = Dry gas volume through meter (standard conditions), cu.ft.

B_{wm} = Approximate volumetric proportion of water vapor in the gas stream leaving the impingers, 0.025.

5. References

Air Pollution Engineering Manual, Danielson, J. A. (ed.), U.S. DHEW, PHS, National Center for Air Pollution Control, Cincinnati, Ohio, PHS Publication No. 999-AP-40, 1967.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, California, November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, California, Bulletin WP-50, 1968.

Method 5 - Determination of Particulate Emissions From Stationary Sources

1. Principle and applicability

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and its weight is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources only when specified by the test procedures for determining compliance with New Source Performance Standards.

2. Apparatus

2.1 Sampling train. The design specifications of the particulate sampling train used by EPA (Figure 5-1) are described in APTD-0581. Commercial models of this train are available.

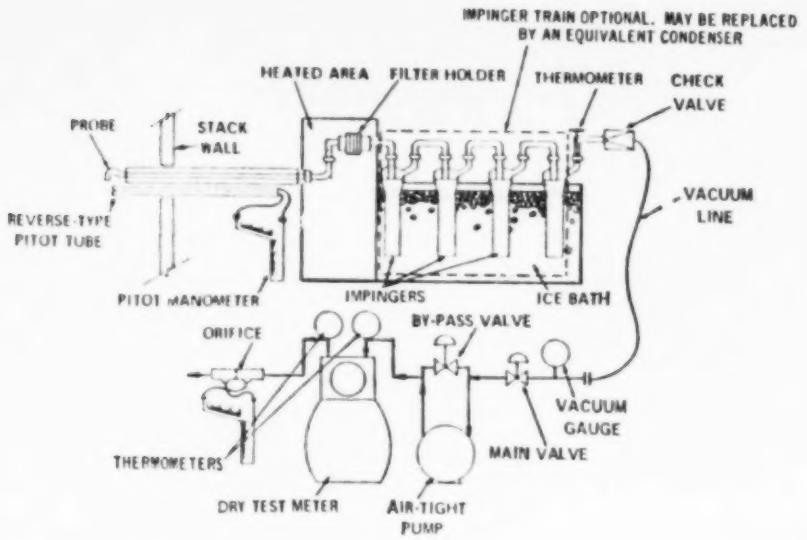


Figure 5-1. Particulate-sampling train.

2.1.1 Nozzle - Stainless steel (316) with sharp, tapered leading edge.

2.1.2 Probe - Pyrex[1] glass with a heating system capable of maintaining a minimum gas temperature of 250°F at the exit end during sampling to prevent condensation from occurring. When length limitations (greater than about 8 ft.) are encountered at temperatures less than 600°F, Incoloy 825[1], or equivalent, may be used. Probes for sampling gas streams at temperatures in excess of 600°F must have been approved by the Administrator.

2.1.3 Pitot tube - Type S, or equivalent, attached to probe to monitor stack gas velocity.

2.1.4 Filter holder - Pyrex[1] glass with heating system capable of maintaining minimum temperature of 225°F.

2.1.5 Impingers/Condenser - Four impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers are of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch ID glass tube extending to one-half inch from the bottom of the flask. The second impinger is of the Greenburg-Smith design with the standard tip. A condenser may be used in place of the impingers provided that the moisture content of the stack gas can still be determined.

2.1.6 Metering system - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2% accuracy, and related equipment, or equivalent, as required to maintain an isokinetic sampling rate and to determine sample volume.

2.1.7 Barometer - To measure atmospheric pressure to ±0.1 inches Hg.

---

[1] Trade name.

2.2 Sample recovery.
2.2.1 Probe brush - At least as long as probe.
2.2.2 Glass wash bottles - Two.
2.2.3 Glass sample storage containers.
2.2.4 Graduated cylinder - 250 ml.
2.3 Analysis.
2.3.1 Glass weighing dishes.
2.3.2 Desiccator.
2.3.3 Analytical balance - To measure to ±0.1 mg.

3. Reagents

3.1 Sampling
3.1.1 Filters - Glass fiber, MSA 1106 BH[1], or equivalent, numbered for identification and preweighed.
3.1.2 Silica gel - Indicating type, 6-16 mesh, dried at 175°C (350°F) for 2 hours.
3.1.3 Water.
3.1.4 Crushed ice.
3.2 Sample recovery.
3.2.1 Acetone - Reagent grade.
3.3 Analysis
3.3.1 Water.
3.3.2 Desiccant - Drierite,[1] indicating.

4. Procedure

4.1 Sampling
4.1.1 After selecting the sampling site and the minimum number of sampling points, determine the stack pressure, temperature, moisture, and range of velocity head.
4.1.2 Preparation of collection train. Weigh to the nearest gram approximately 200 g. of silica gel. Label a filter of proper diameter, desiccate[2] for at least 24 hours and weigh to the nearest 0.5 mg. in a room where the relative humidity is less than 50%. Place 100 ml. of water in each of the first two impingers, leave the third impinger empty, and place approximately 200 g. of preweighed silica gel in the fourth impinger. Set up the train without the probe as in Figure 5-1. Leak check the sampling train at the sampling site by plugging up the inlet to the filter holder and pulling a 15 in. Hg vacuum. A leakage rate not in excess of 0.02 c.f.m. at a vacuum of 15 in. Hg is acceptable. Attach the probe and adjust the heater to provide a gas temperature of about 250°F at the probe outlet. Turn on the filter heating system. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger as low as possible and preferably at 70°F or less. Temperatures above 70°F may result in damage to the dry gas meter from either moisture condensation or excessive heat.

---

[1] Trade name.

[2] Dry using Drierite[1] at 70°F ±10°F.

4.1.3 Particulate train operation. For each run, record the data required on the example sheet shown in Figure 5-2. Take readings at each sampling point, at least every 5 minutes, and when significant changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period. Nomographs are available which aid in the rapid adjustment of the sampling rate without other computations. APTD-0576 details the procedure for using these nomographs. Turn off the pump at the conclusion of each run and record the final readings. Remove the probe and nozzle from the stack and handle in accordance with the sampling recovery process described in section 4.2.

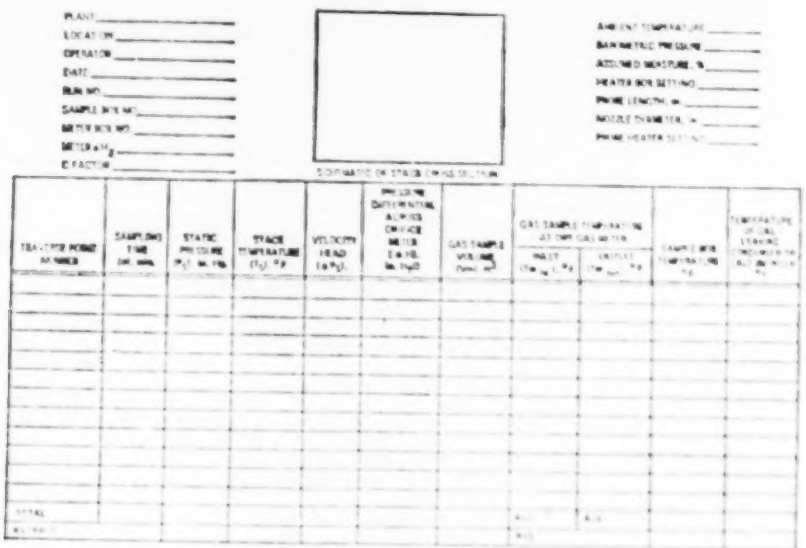


Figure 5-2. Particulate field data.

4.2 Sample recovery. Exercise care in moving the collection train from the test site to the sample recovery area to minimize the loss of collected sample or the gain of extraneous particulate matter. Set aside a portion of the acetone used in the sample recovery as a blank for analysis. Measure the volume of water from the first three impingers, then discard. Place the samples in containers as follows:

Container No. 1. Remove the filter from its holder, place in this container, and seal.

Container No. 2. Place loose particulate matter and acetone washings from all sample-exposed surfaces prior to the filter in this container and seal. Use a razor blade, brush, or rubber policeman to lose adhering particles.

Container No. 3. Transfer the silica gel from the fourth impinger to the original container and seal. Use a rubber policeman as an aid in removing silica gel from the impinger.

4.3 Analysis. Record the data required on the example sheet shown in Figure 5-3. Handle each sample container as follows:

PLANT _____

DATE _____

RUN NO. _____

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			
2			
TOTAL			

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g*	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g ml):

$$\frac{\text{INCREASE, g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

Figure 5-3. Analytical data.

Container No. 1. Transfer the filter and any loose particulate matter from the sample container to a tared glass weighed dish, desiccate, and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 2. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 3. Weigh the spent silica gel and report to the nearest gram.

5. Calibration

Use methods and equipment which have been approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater. Recalibrate after each test series.

6. Calculations

6.1 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.2 Dry gas volume. Correct the sample volume measured by the dry gas meter to standard conditions (70°F, 29.92 inches Hg) by using Equation 5-1.

$$V_{m_{std}} = V_m \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right) = \left(17.71 \ \frac{°R}{in.Hg}\right) V_m \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right) \qquad \text{equation 5-1}$$

where:

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

V_m = Volume of gas sample through the dry gas meter (meter conditions), cu. ft.

T_{std} = Absolute temperature at standard conditions, 530°R.

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, inches Hg.

ΔH = Average pressure drop across the orifice meter, inches H_2O.

13.6 = Specific gravity of mercury.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6.3 Volume of water vapor.

$$V_{w_{std}} = V_{1_c}\left(\frac{\rho_{H_2O}}{M_{H_2O}}\right)\left(\frac{RT_{std}}{P_{std}}\right) = \left(0.0474\ \frac{\text{cu. ft.}}{\text{ml.}}\right) V_{1_c} \qquad \text{equation 5-2}$$

where:

$V_{w_{std}}$ = Volume of water vapor in the gas sample (standard conditions), cu. ft.

V_{1_c} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

R = Ideal gas constant, 21.83 inches Hg-cu. ft./lb.-mole-°R.

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6.4 Moisture content.

$$B_{wo} = \frac{V_{w_{std}}}{V_{m_{std}} + V_{w_{std}}} \qquad \text{equation 5-3}$$

where:

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

$V_{w_{std}}$ = Volume of water in the gas sample (standard conditions), cu. ft.

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

6.5 Total particulate weight. Determine the total particulate catch from the sum of the weights on the analysis data sheet (Figure 5-3).

6.6 Concentration.

6.6.1 Concentration in gr./s.c.f.

$$c'_s = \left(0.0154\ \frac{\text{gr.}}{\text{mg.}}\right)\left(\frac{M_n}{V_{m_{std}}}\right) \qquad \text{equation 5-4}$$

where:

c'_s = Concentration of particulate matter in stack gas, gr./s.c.f., dry basis.

M_n = Total amount of particulate matter collected, mg.

$V_{m_{std}}$ = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.6.2 Concentration in lb./cu. ft.

$$c_s = \frac{\left(\frac{1}{453,600} \frac{lb.}{mg.}\right) M_n}{V_{m_{std}}} = 2.205 \times 10^{-6} \frac{M_n}{V_{m_{std}}} \qquad \text{equation 5-5}$$

where:

C_a = Concentration of particulate matter in stack gas, lb./s.c.f., dry basis.

453,600 = Mg/lb.

M_n = Total amount of particulate matter collected, mg.

$V_{m_{std}}$ = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.7 Isokinetic variation.

$$I = \frac{T_s \left[\frac{V_{l_c} \rho_{H_2O} R}{M_{H_2O}} + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\theta V_s P_s A_n} \times 100$$

$$= \frac{\left(1.667 \frac{min.}{sec.}\right)\left[\left(0.00267 \frac{in.\ Hg\text{-}cu.\ ft.}{ml.\ \cdot\ ^\circ R}\right) V_{l_c} + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\theta V_s P_s A_n} \qquad \text{equation 5-6}$$

where:

I = Percent of isokinetic sampling.

V_{l_c} = Total volume of liquid collected in impingers and silica gel (See Fig. 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

R = Ideal gas constant, 21.83 inches Hg-cu. ft./lb. mole-°R.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

V_m = Volume of gas sample through the gas meter (meter conditions), cu. ft.

T_m = Absolute average dry gas meter temperature (See Figure 5-2), °R.

P_{bar} = Barometric pressure at sampling site, inches Hg.

ΔH = Average pressure drop across the orifice (see Fig. 5-2), inches H_2O.

T_s = Absolute average stack gas temperature (see Fig. 5-2), °R.

θ = Total sampling time, min.

V_s = Stack gas velocity calculated by Method 2, Equation 2.2, ft./sec.

P_s = Absolute stack gas pressure, inches Hg.

A_n = Cross-sectional area of nozzle, sq. ft.

6.8 Acceptable results. The following range sets the limit on acceptable isokinetic sampling results:

If 90% $\leq I \leq$ 110%, the results are acceptable, otherwise, reject the results and repeat the test.

7. Reference.

Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, Dec. 6, 1967.

Martin, Robert M., Construction Details of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0581.

Rom, Jerome J., Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0576.

Smith, W. S., R.T. Shigehara, and W. F. Todd, A Method of Interpreting Stack Sampling Data, Paper presented at the 63rd Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14-19, 1970.

Smith, W. S., et.al., Stack Gas Sampling Improved and Simplified with New Equipment, APCA paper No. 67-119, 1967.

Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, 1967.

APPENDIX B

SUGGESTED CONTENTS OF STACK TEST REPORTS

CONTENTS OF STACK TEST REPORTS

In order to adequately assess the accuracy of any test report the basic information listed in the following suggested outline is necessary:

1. Introduction. Background information pertinent to the test is presented in this section. This information shall include, but not be limited to, the following:

   a. Manufacturer's name and address.

   b. Name and address of testing organization.

   c. Names of persons present, dates and location of test.

   d. Schematic drawings of the process being tested showing emission points, sampling sites, and stack cross section with the sampling points labeled and dimensions indicated.

2. Summary. This section shall present a summary of test findings pertinent to the evaluation of the process with respect to the applicable emission standard. The information shall include, but not be limited to, the following:

   a. A summary of emission rates found.

   b. Isokinetic sampling rates achieved if applicable.

   c. The operating level of the process while the tests were conducted.

3. Procedure. This section shall describe the procedures used and the operation of the sampling train and process during the tests. The information shall include, but not be limited to, the following:

   a. A schematic drawing of the sampling devices used with each component designated and explained in a legend.

   b. A brief description of the method used to operate the sampling train and procedure used to recover samples.

4. Analytical Technique. This section shall contain a brief description of all analytical techniques used to determine the emissions from the source.

5. Data and Calculations. This section shall include all data collected and calculations. As a minimum, this section shall contain the following information:

   a. All field data collected on raw data sheets.

   b. A log of process and sampling train operations.

   c. Laboratory data including blanks, tare weights, and results of analysis.

   d. All emission calculations.

6. Chain of Custody. A listing of the chain of custody of the emission test samples.

7. Appendix:

   a. Calibration work sheets for sampling equipment.

   b. Calibration or process logs of process parameters.

APPENDIX C

VISIBLE EMISSION OBSERVATION FORM

FIGURE 9-1
RECORD OF VISUAL DETERMINATION OF OPACITY

PAGE___of___

COMPANY_____
LOCATION_____
TEST NUMBER_____
DATE_____
TYPE FACILITY_____
CONTROL DEVICE_____

HOURS OF OBSERVATION_____
OBSERVER_____
OBSERVER CERTIFICATION DATE_____
OBSERVER AFFILIATION_____
POINT OF EMISSIONS_____
HEIGHT OF DISCHARGE POINT_____

	Initial			Final
CLOCK TIME				
OBSERVER LOCATION Distance to Discharge				
Direction from Discharge				
Height of Observation Point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time	Opacity	
	Start--End	Sum	Average

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time evaluation was made.

FIGURE 9-2 OBSERVATION RECORD PAGE ___ OF ___

COMPANY _____ OBSERVER _____
LOCATION _____ TYPE FACILITY _____
TEST NUMBER _____ POINT OF EMISSIONS _____
DATE _____

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							
	27							
	28							
	29							

FIGURE 9-2 OBSERVATION RECORD (Continued) PAGE ___ OF ___

COMPANY _____ OBSERVER _____
LOCATION _____ TYPE FACILITY _____
TEST NUMBER _____ POINT OF EMISSIONS _____
DATE _____

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
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	42							
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	59							

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